2018

Resilient Flagler County

Prepared by the Northeast Florida Regional Council (NEFRC) for Flagler County and the River to Sea Transportation Planning Organization

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Executive Summary

Flooding and storms have become more frequent across Florida's coastal communities due to changing climate and sea level rise. Local governments and residents are starting to see the beginning impacts sea level rise combined with storms will have on their community. The U.S. Army Corps of Engineers predicts sea level rise along Daytona Beach Shores to be between 0.82 feet to 5.15 feet by 2100. This, along with a 100-year storm, could mean devastation to coastal communities if appropriate planning and action is not taken early enough.

To build resiliency against flooding and sea level rise, Flagler County along with the City of Palm Coast and City of Flagler Beach participated with Northeast Florida Regional Council (NEFRC), the River to Sea Transportation Planning Organization, and UF Geoplan to assess impacts. Using the FDOT Sea Level Scenario Sketch Planning Tool along with FEMA's Hazus-MH software, impacts of sea level rise, combined with a 100-year-storm were modeled.

Using these models and Flagler County data, critical assets and facilities were assessed to determine potential impacts during such a 100-year storm event with increased coastal flooding. Assessments also included significant evacuation routes and impacts to County facilities. After analyzing the data Flagler Stakeholders can now begin to prepare for the future impacts of a 100-year storm as sea levels rise.

The study also looked at the different approaches Flagler Stakeholders can use to build resiliency including retreat, accommodate, and protect. Resources, along with recommendations for implementing new data and strategies, policies and information into existing plans throughout the county were discussed. Emphasis was placed on emergency preparedness, land-use, and transportation. The data, resources and recommendations within this report will provide Flagler County and the implementers of the plan with a solid foundation to guide conversations and coordination to determine the appropriate approach in each situation. It is important that coastal communities like Flagler County begin to carefully assess their vulnerability to ensure resiliency.

Photo Courtesy of Flagler County
When: aftermath of Hurricane Irma, Sept. 11, 2017.
Where: View from SR 100 and Flagler Ave. looking south, Flagler Beach.

Acknowledgements

We would like to thank our partners including the Florida Department of Environmental Protection – Coastal Partnership Initiative Grant, Flagler County, River to Sea TPO, East Central Florida Regional Planning Council, Florida Department of Transportation, and especially Crystal Goodison and her students and staff at UF GeoPlan.

The Resilient Flagler County Plan was developed using the Resilient Volusia County Plan methodology which preceded it. The Resilient Flagler Planning team acknowledges the subject matter experts from throughout Volusia County and from several public agencies that created and vetted the methodology. We thank them for their time and leadership.

As part of this project, a stakeholder group was developed to oversee the project and model implementation. Thank you to those members of the leadership team for their time, insight and direction.

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Background

Flagler County, in partnership with the Northeast Florida Regional Council, the River to Sea Transportation Planning Organization, and UF Geoplan, received a Florida Department of Environmental Protection Coastal Partnership Initiative Grant to assess impacts sea level rise may have on the 100-year storm coastal flooding levels and extent. These modeling results were piloted through the Sea Level Scenario Sketch Planning Tool through a coordinated review and analysis process.

In an effort to develop appropriate data and analysis for decision making as well as coastal resiliency strategies for the County and provide quality review and input on a model for statewide utilization, the NEFRC, Flagler County and partners, through this grant project:

1) Conducted a quality assurance review of model outputs;
2) Analyzed new impact areas resulting from 100-year storm coastal flooding (inclusive of storm surge) based on sea level rise projections resulting from the FDOT Sea Level Scenario Sketch Planning Tool;
3) Identified implementation strategies and educational materials to enhance community resiliency in all aspects for departments within Flagler County, its cities, as well as FDOT and the TPO.

As noted in the methodology section of this report, UF GeoPlan Center team utilized FEMA's Hazus-MH software for modeling 100-year flood hazard areas with the addition of sea level rise resulting from new climate effects. The project team provided a quality assurance review of these data utilizing various experts from local, county, and regional agencies.

Using the modeled data, the team analyzed impacts on critical assets such as evacuation routes and other critical infrastructure necessary for economic and community resiliency. Analyzing the new flood impacts provides emergency management with the critical information to develop necessary response plans and continued collaboration between critical agencies.

Coastal Flooding/ Surge Modeling Methods

Sea level rise (SLR) is expected to exacerbate coastal flooding events, increasing the extent and depth of flooding as well as the intensity of damage from storms. For this project, researchers from the University of Florida GeoPlan Center modeled future coastal flood risk under sea level rise scenarios using FEMA's Hazus-MH software. The goal of this modeling was to estimate the depth and extent of coastal flooding under future sea level rise conditions and assess those impacts to the transportation network and critical facilities. The outputs of the model do not include inland flood impacts from the St. Johns River. The model is strictly elevation based and does not consider flood control mechanisms such as weirs or similar infrastructure, and does not show their impacts on flooding. Communities such as Palm Coast have networks of canals and weirs designed to control flooding. Planners working on projects near to flood control devices such as weirs should identify the location of such devices and analyze how the device or devices will impact flooding in that area. An additional level of site-specific analysis will be required in order to take the impact of flood control devices into account.

Background: Hazus-MH - Multi-Hazard Loss Estimation Methodology

The Multi-Hazard Loss Estimation Methodology (Hazus-MH) is a standardized methodology created by the Federal Emergency Management Administration (FEMA) to estimate potential losses from earthquakes, hurricane winds, and floods. Hazus-MH contains multiple models for estimating losses from various hazards, including the Earthquake Model, the Flood Model, and the Hurricane Model.

The Flood Model is used to estimate riverine and coastal flood hazards and potential damage to buildings, infrastructure, and land use. The software models specific return intervals of flooding (such as the 100-year return interval or commonly referred to "100-year flood event" or "100-year storm") and damages resulting from those events. The Hurricane Wind Model is used to estimate hurricane winds and potential damage to buildings for the Atlantic and Gulf Coast regions and Hawaii. There is also an option to model the combined flood and wind hazards to produce hurricane-induced coastal surge. FEMA's Hazus-MH website: https://www.fema.gov/hazus

Method: Hazus-MH Coastal Flood Hazards Model: Analyzing 100-year storms-surge with SLR Scenarios

The method to model potential future storm surge utilized the Coastal Flood Hazards component of the Hazus-MH Flood Model. This model follows FEMA's methodology for developing the Flood Insurance Rate Maps (FIRMs), where flood frequency and flood magnitude (or depth) are used to define flood hazard. The model relies on the 100-year Stillwater elevation (SWEL) and Stillwater depth (SWD) to identify the inland impacts of storm surge. Coastal flooding scenarios were run on the entire Atlantic coastline of Flagler County using the FEMA 100-year or 1% annual chance flood event as a baseline scenario. Nine scenarios of future SLR were then modeled by adding the SLR amounts to the coastal Stillwater elevations for the base 100-year storm.

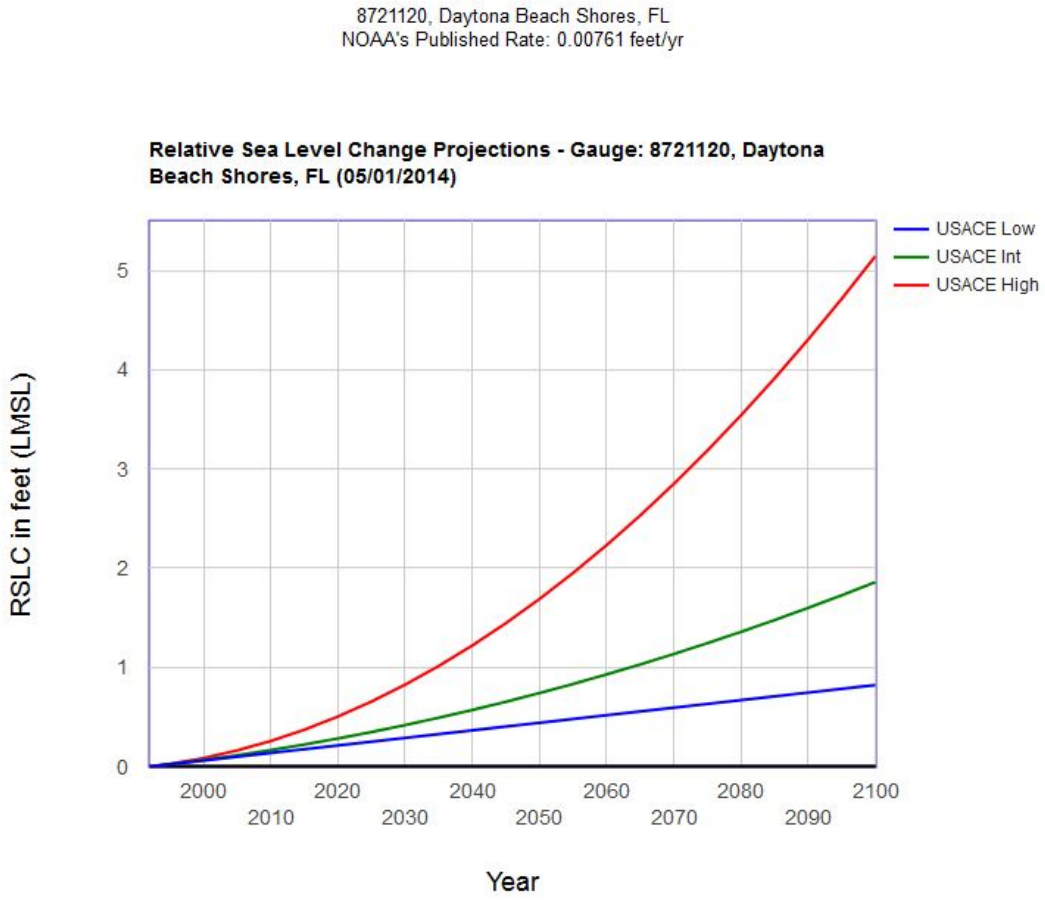
The SLR scenarios used for these model runs are from the U.S. Army Corps of Engineers, and are consistent with the modeling and vulnerability analysis conducted by the East Central Florida Regional Council for other counties and communities in the east central Florida region. In Table 1 (below), the SLR values are listed in feet, relative to mean sea level (MSL), and utilizing local sea level trend information from the Daytona Beach Shores tide station. At 2040, the range of projected SLR is from 0.37-feet to 1.22-feet. At 2070, the range of projected SLR is 0.59-feet to 2.85-feet. At 2100, the range of projected SLR is from 0.82-feet to 5.15-feet. Table 2 below is a graph plotting the SLR values in Table 1.

Table 1: U.S. Army Corps of Engineers Sea Level Rise Projections in Feet, Daytona Beach Shores, FL

USACE SLR Projections
Feet of RSLR (relative to MSL)
Daytona Beach Shores Tide Location, FL

Year	Low	Intermediate	High
2040	0.37 ft	0.57 ft	1.22 ft
2070	0.59 ft	1.14 ft	2.85 ft
2100	0.82 ft	1.86 ft	5.15 ft

Table 2: Relative Sea Level Change Projections, Daytona Beach Shores, FL
U.S. Army Corps of Engineers sea-level change calculator



The Hazus-MH software allows the user to enter the Stillwater elevations for different flooding event return rates (for example: 10% annual chance, 2% annual chance, 1% annual chance, 0.2% annual chance). SWELs for the 1% annual chance flood were obtained from the 2014 FEMA Flood Insurance Study (FIS) for Flagler County.

For each of the nine scenarios, the relative SLR amount was added to the Stillwater Elevation (SWEL), to represent a future SWEL. The Coastal Flood Hazard Model was then run with the future SWEL. A 5-meter Digital Elevation Model (DEM), compiled with Lidar data by the GeoPlan Center, was used for the modeling. The model outputs include depth grids of the 100-year storm surge which were then overlaid with data to analyze impacts under each of the nine scenarios.

The scenarios do not include inland flood impacts from the St. Johns River. This modeling will need to be discussed further with UF Geoplan to determine feasibility and methodology to incorporate this information in the future.

Hazus Caveats

The purpose of the Hazus-MH modeling was to estimate the extent and depth of coastal flooding under a future 100-year storm event including the sea level rise conditions. While the Hazus-MH Flood Model uses a similar methodology for developing the Digital Flood Insurance Rate Maps (DFIRMs), the model results should not be confused with the 100-year floodplain maps, which delineate current flood risks. The base 100-year flood modeled with Hazus may differ with the 100-year coastal floodplain DFIRM due to different elevation data inputs, flood model simplifications, and flood model enhancements:

- The elevation data used to create the DFIRMs may be different than what was used in Hazus. For the Hazus flood modeling for this project, the GeoPlan Center used a lidar-based Digital Elevation Model that was approximately 5.4-meter in horizontal resolution (cell size). Both the resolution of the elevation data and the resolution (or cell size) at which the models were processed have an impact on the resulting areas identified as flooded. Generally, the lower the cell size, the higher the accuracy of the output model results.
- The Hazus flood model is similar to the DFIRM methodology, but contains model simplifications that allow users to estimate flood hazards with less input and knowledge.
- Additionally, Hazus contains flood model enhancements that "extend and improve some aspects of FEMA's models, by incorporating more recent scientific developments" (FEMA, Multi-hazard Loss Estimation Methodology Flood Technical Manual, p. 4-77).

How the Hazus Outputs Can Be Used

The Hazus outputs can be used by emergency management staff, planning departments, floodplain managers, and resiliency planners for hazard identification, risk assessment, mitigation planning, and emergency preparedness. Rising sea levels are expected to increase the extent, depth, and frequency of coastal flooding. Hence, it is important to overlay the Hazus model results with other model results of current and future flood risk to get a more comprehensive picture of flood risk for an area. For example, these maps can be used in combination with current floodplain maps, current storm surge zones, and future sea level rise. Together, these overlays can estimate areas more prone to future flood risk, based on current flood risk and rising sea levels. These model results should not be used to determine regulatory floodplain areas or building-specific locations. While Hazus can estimate individual building losses, the results should be considered as an average for a group of similar buildings. These model results are estimates of future flood risk based on the best available elevation data, current Hazus flood models, and projections of sea level rise. The models should be updated in the future to reflect the best available elevation data and climate science.

Analysis Findings

Infrastructure and transportation facility data was collected from Flagler County and available NEFRC datasets. Facilities that were assessed through this analysis include:

- Significant Evacuation Routes
- Significant Roads
- Public Works Facilities
- Critical Facilities
- Community Centers
- Other County/City Facilities

ALLOWABLE RISK AND LIFE SPAN SHOULD BE CONSIDERED WHEN PLANNING FOR SEA LEVEL RISE. RANGES BETWEEN SCENARIOS SHOULD BE EXAMINED BASED UPON PLANNING HORIZONS AND SPECIFIC FACILITY PLANNING

Each area was analyzed based on the 100-year storm coastal flooding and each of the sea level rise scenarios, low, intermediate and high, for the years 2040, 2070, and 2100. While the tables depict all the scenarios, concentration of discussion pertains mainly to the intermediate and high scenarios. This is due to the fact that the low scenario is based on historical sea level rise and does not incorporate changing conditions. Therefore, this run is primarily for comparison purposes only.

Land Area and Depth

The land area analysis examined the total acreage in Flagler and possible percentage of coastal flooding with a 100-year storm. Flagler County has many low-lying coastal areas making it susceptible to flooding events that can be intensified greatly by sea level rise. Without accounting for sea level rise, a 100-year coastal flood event would leave approximately 3.1% of Flagler flooded today. Table 3 below shows how much sea level rise will increase this extent of flooding. The intermediate scenario anticipates a 21% increase in coastal flood extent by 2070, impacting 4.3% of the county and a 30% increase by 2100. In the 2100 high scenario, almost 6.4% of Flagler will be vulnerable to flooding; an approximate 47% increase from the base 100-year storm coastal flood, while 38% of this increased coastal flooding may be recognized by the year 2070. The areas around Beverly Beach and Flagler Beach are also expected to see increased extents of coastal flooding, as well as the Marineland area.

Assessing which areas are most susceptible to flooding and planning mitigation actions now can decrease future damage of flooding. If an area is known to flood, action should be taken to relocate critical infrastructure in the near future and also limit new development in the area. The pages that follow include depth maps depicting the modeled 100-year storm coastal flood areas and depth respective to each sea level rise scenario and year.

Table 3: Coastal Flood Extent Change by SLR Scenario and Year

Hazus-MH Coastal Flood Model Run	Total Acreage Flooded	Percent of Flagler Flooded	Percent Change
Base 100-year	12,406	3.4%	
100-year + 2040 Low SLR	13,636	3.7%	9%
100-year + 2070 Low SLR	14,167	3.9%	12%
100-year + 2100 Low SLR	14,968	4.1%	17%
100-year + 2040 Int SLR	14,167	3.9%	12%
100-year + 2070 Int SLR	15,772	4.3%	21%
100-year + 2100 Int SLR	17,709	4.8%	30%
100-year + 2040 High SLR	15,912	4.4%	22%
100-year + 2070 High SLR	20,012	5.5%	38%
100-year + 2100 High SLR	23,272	6.4%	47%

Due to the topography of the County, as higher levels of sea level were added to the base flood, not only did the extent of flooding increase, the depth of flooding increased in vulnerable areas. The modeling projects that by 2040, when using the intermediate to high scenario range, an increase of 0.57-1.22 feet (14.99-15.64 feet max depth) of flood depth above the 100-year Stillwater elevation can be expected; by 2070, an increase of 1.14-2.85 feet (15.56-17.27 feet max depth); and by 2100, an increase of 1.86-8.25 (16.28-22.67 feet max depth). Areas that may experience the greatest change in flood depth should be examined and stakeholders should consider potential changes to building codes, mitigation opportunities and other strategies to protect life and property as well as critical facilities and major transportation facilities that would be essential for evacuations and recovery. These facilities not only include governmental facilities but also businesses critical to community recovery such as food stores, electrical and water suppliers and others.

Table 4: Coastal Flood Depth Change by SLR Scenario and Year

Hazus-MH Coastal Flood Model Run	Max Flood Depth (Inches)	Max Flood Depth (Feet)	Increase (feet)	RSLR Feet
Base 100-year	173	14.42		0
100-year + 2040 Low SLR	177	14.79	0.37	0.37
100-year + 2070 Low SLR	180	15.01	0.59	0.59
100-year + 2100 Low SLR	183	15.24	0.82	0.82
100-year + 2040 Int SLR	179	14.99	0.57	0.57
100-year + 2070 Int SLR	187	15.56	1.14	1.14
100-year + 2100 Int SLR	195	16.28	1.86	1.86
100-year + 2040 High SLR	188	15.64	1.22	1.22
100-year + 2070 High SLR	207	17.27	2.85	2.85
100-year + 2100 High SLR	272	22.67	8.25	5.15

Photo Courtesy of Flagler County
When: Aftermath of Hurricane Irma, September 11, 2017
Where: View north along the Intracoastal Waterway from SR 100 bridge in Flagler Beach

Figure 1: 100-Year Storm Coastal Flood Depth 2040 Low

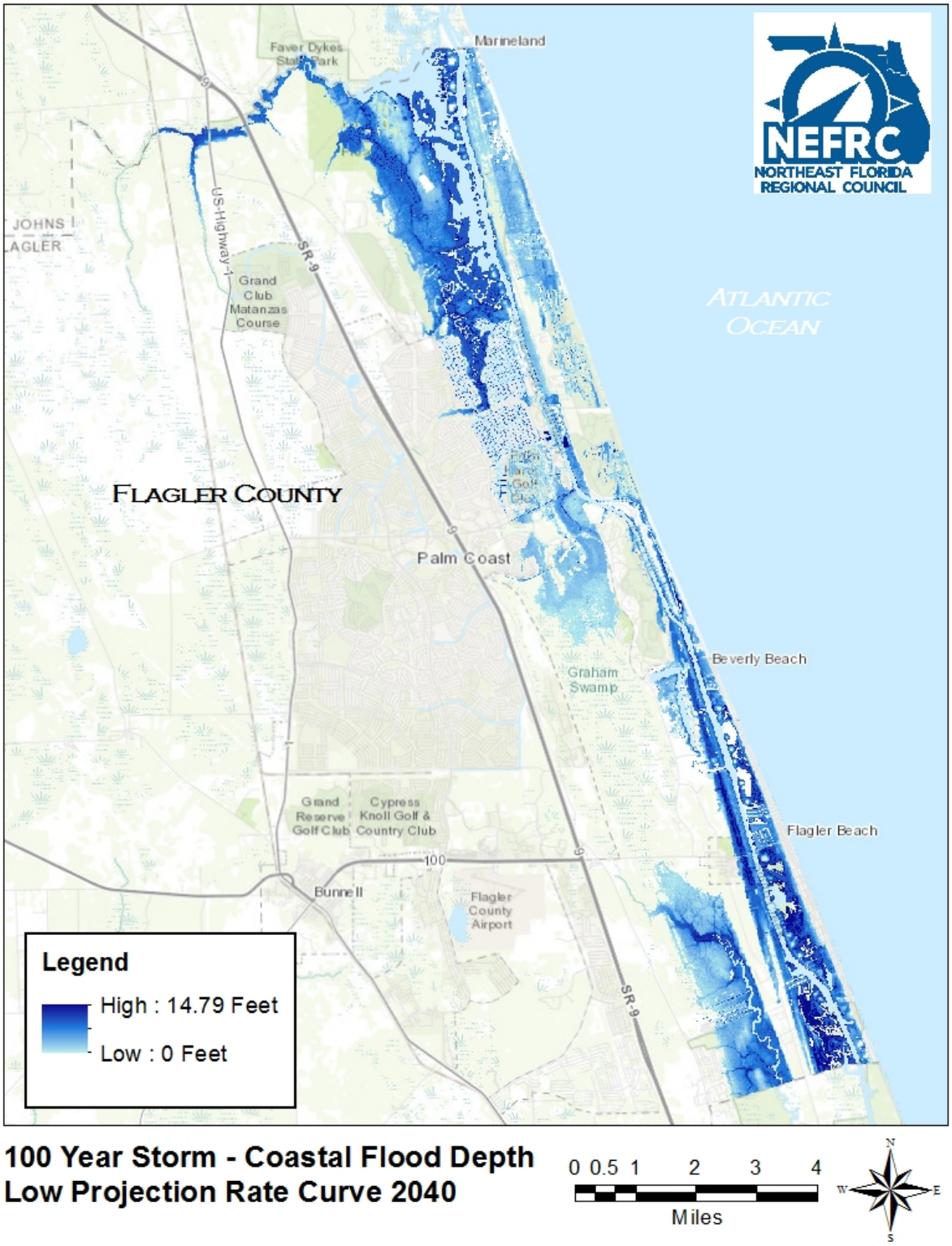


Figure 2: 100-Year Storm Coastal Flood Depth 2070 Low

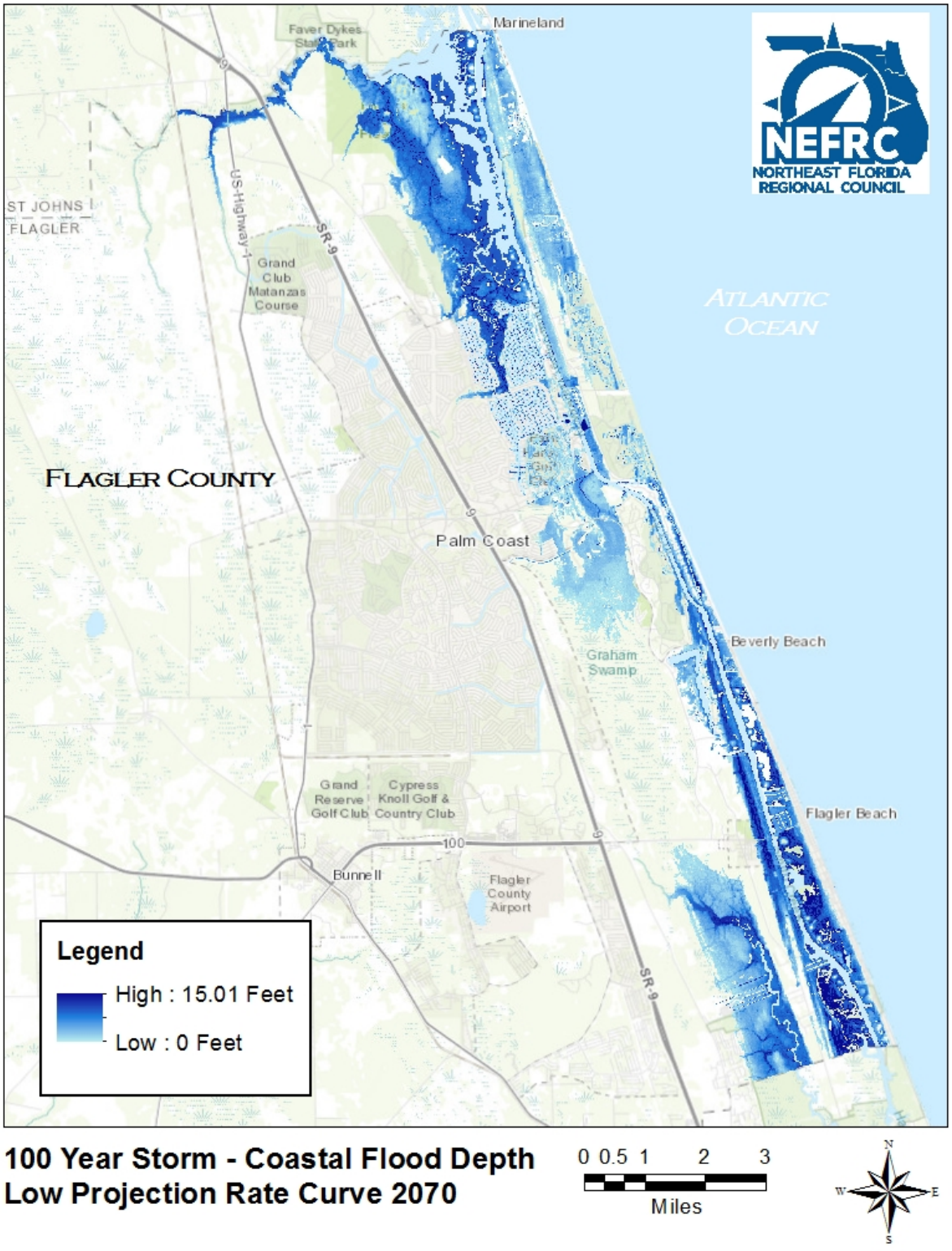


Figure 3: 100-Year Storm Coastal Flood Depth 2100 Low

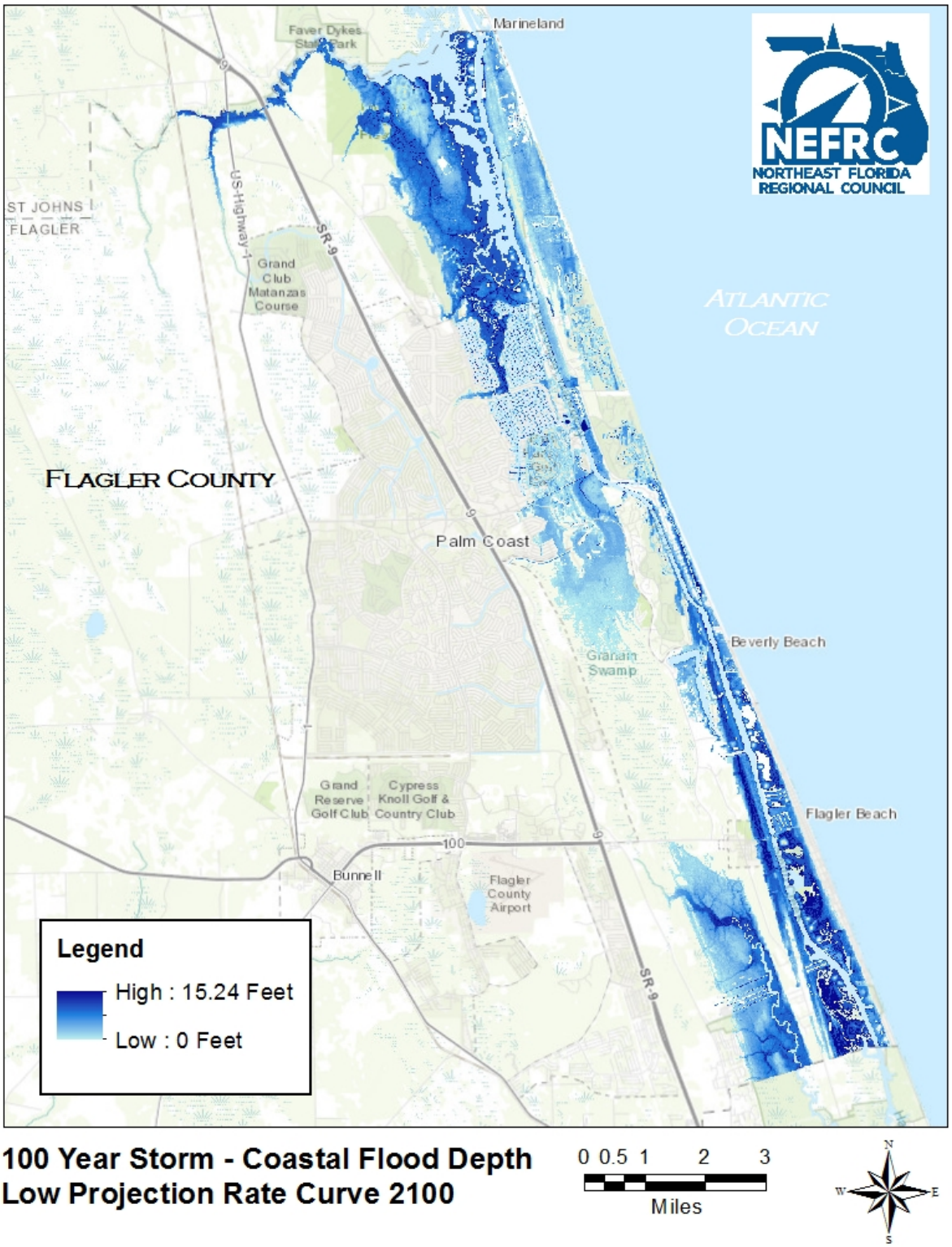


Figure 4: 100-Year Storm Coastal Flood Depth 2040 Intermediate

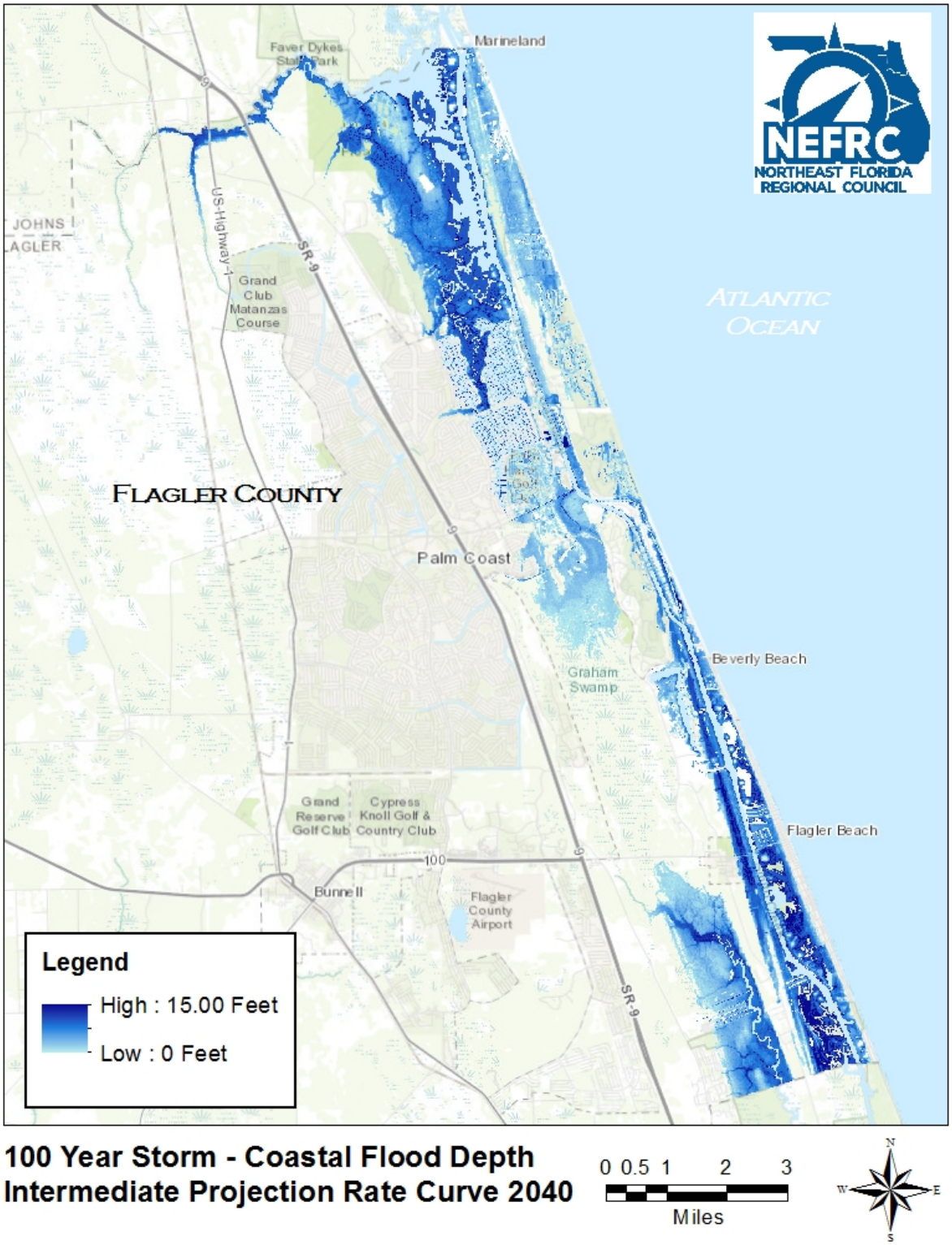


Figure 5: 100-Year Storm Coastal Flood Depth 2070 Intermediate

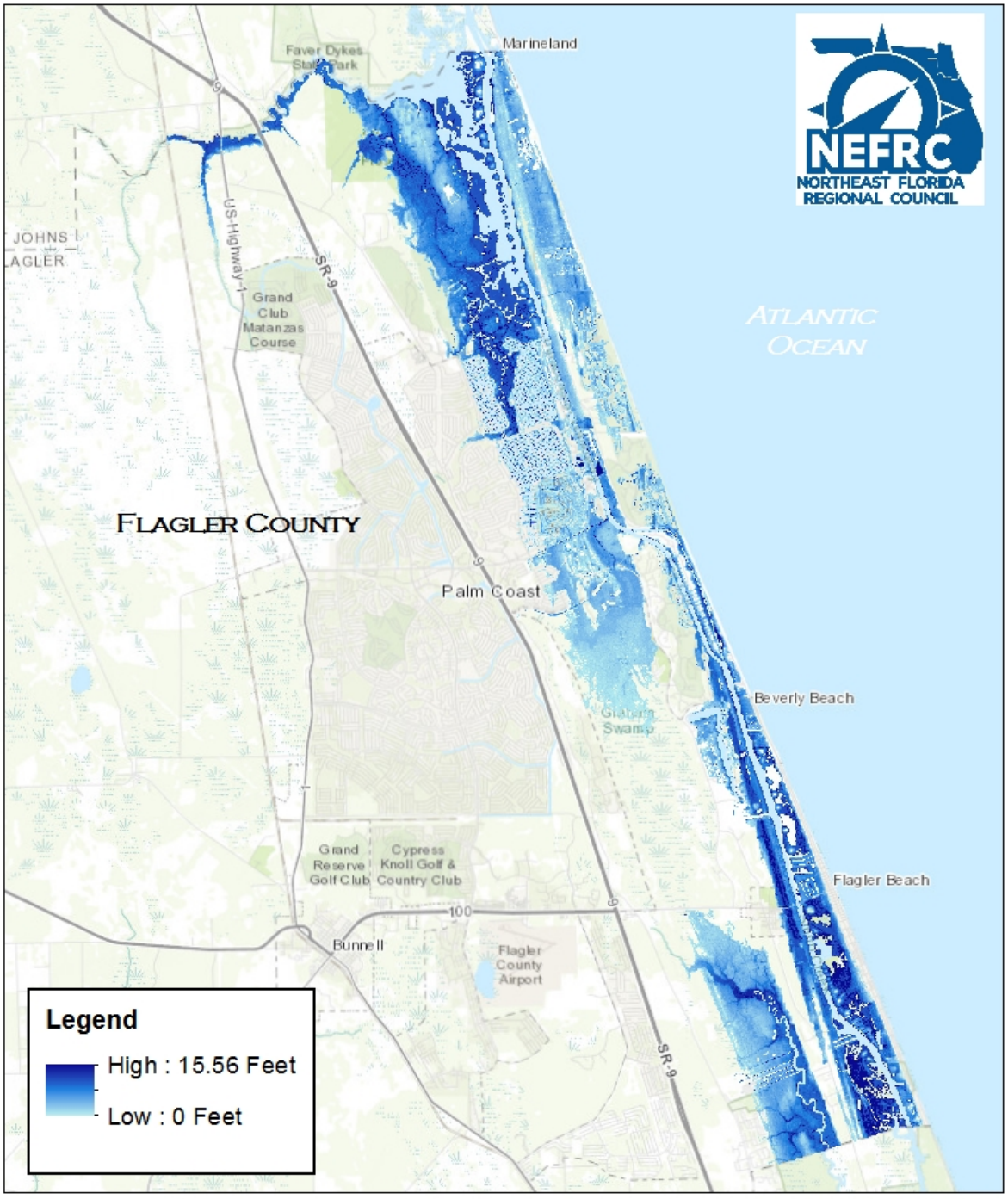


Figure 6: 100-Year Storm Coastal Flood Depth 2100 Intermediate

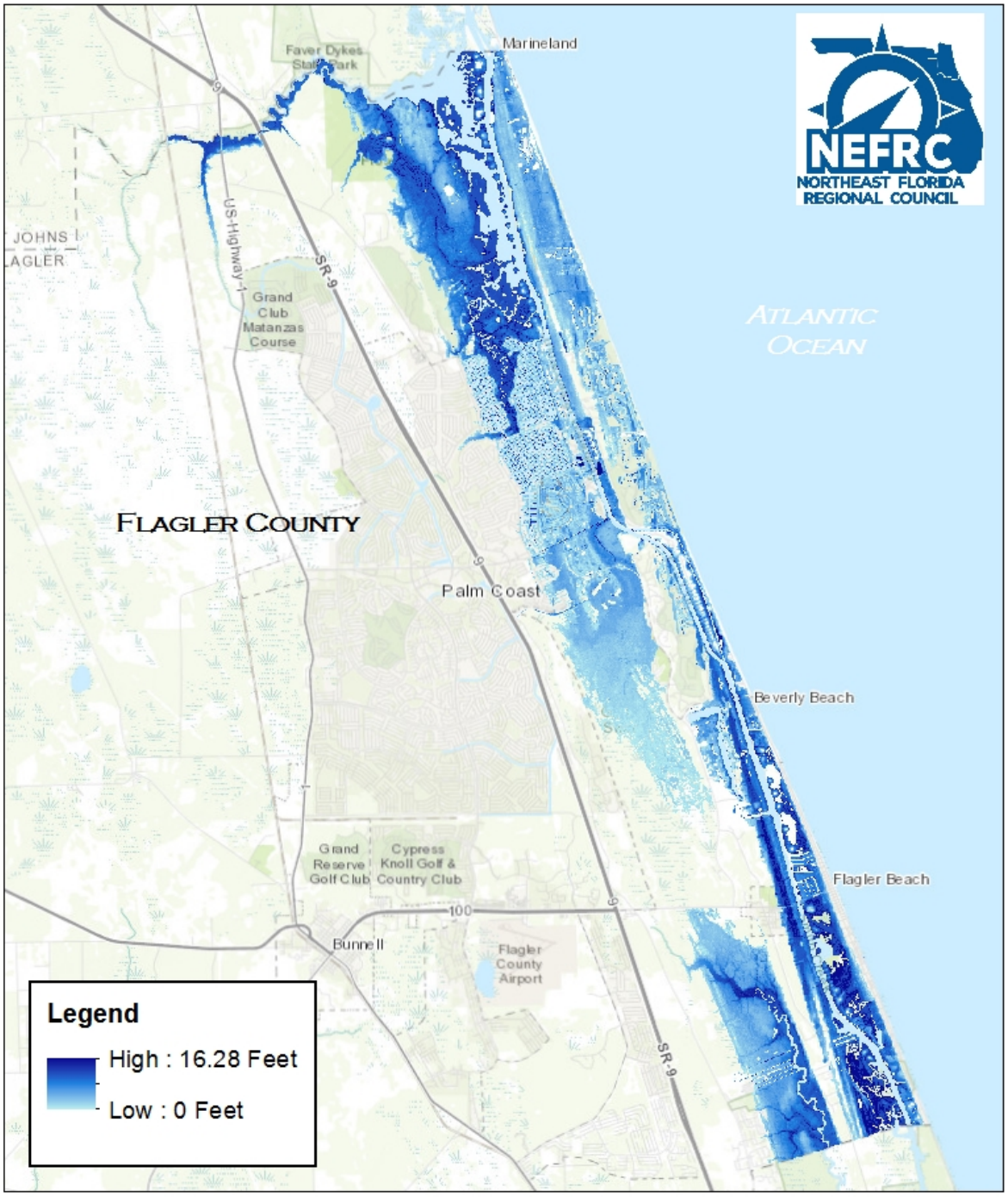


Figure 7: 100-Year Storm Coastal Flood Depth 2040 High

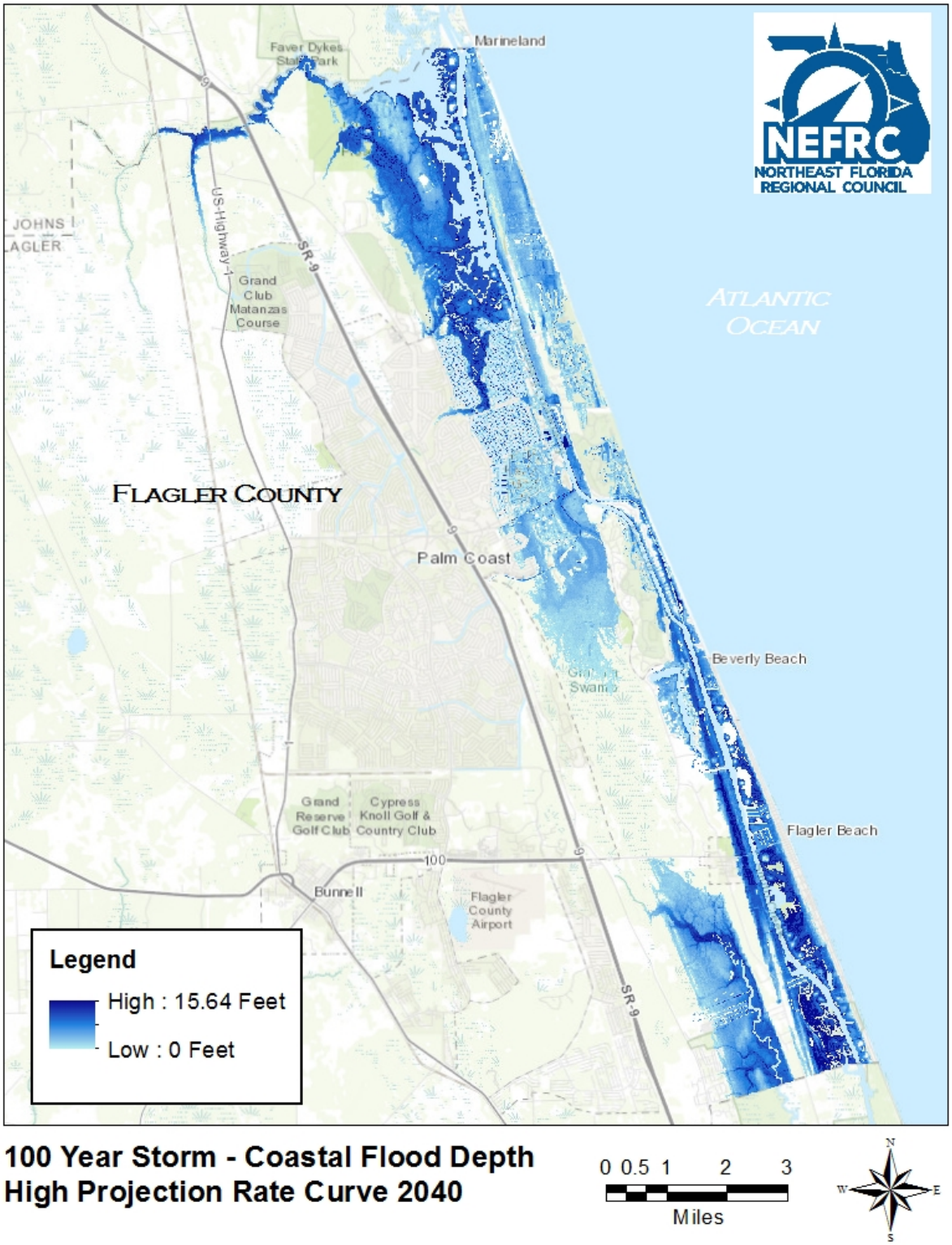


Figure 8: 100-Year Storm Coastal Flood Depth 2070 High

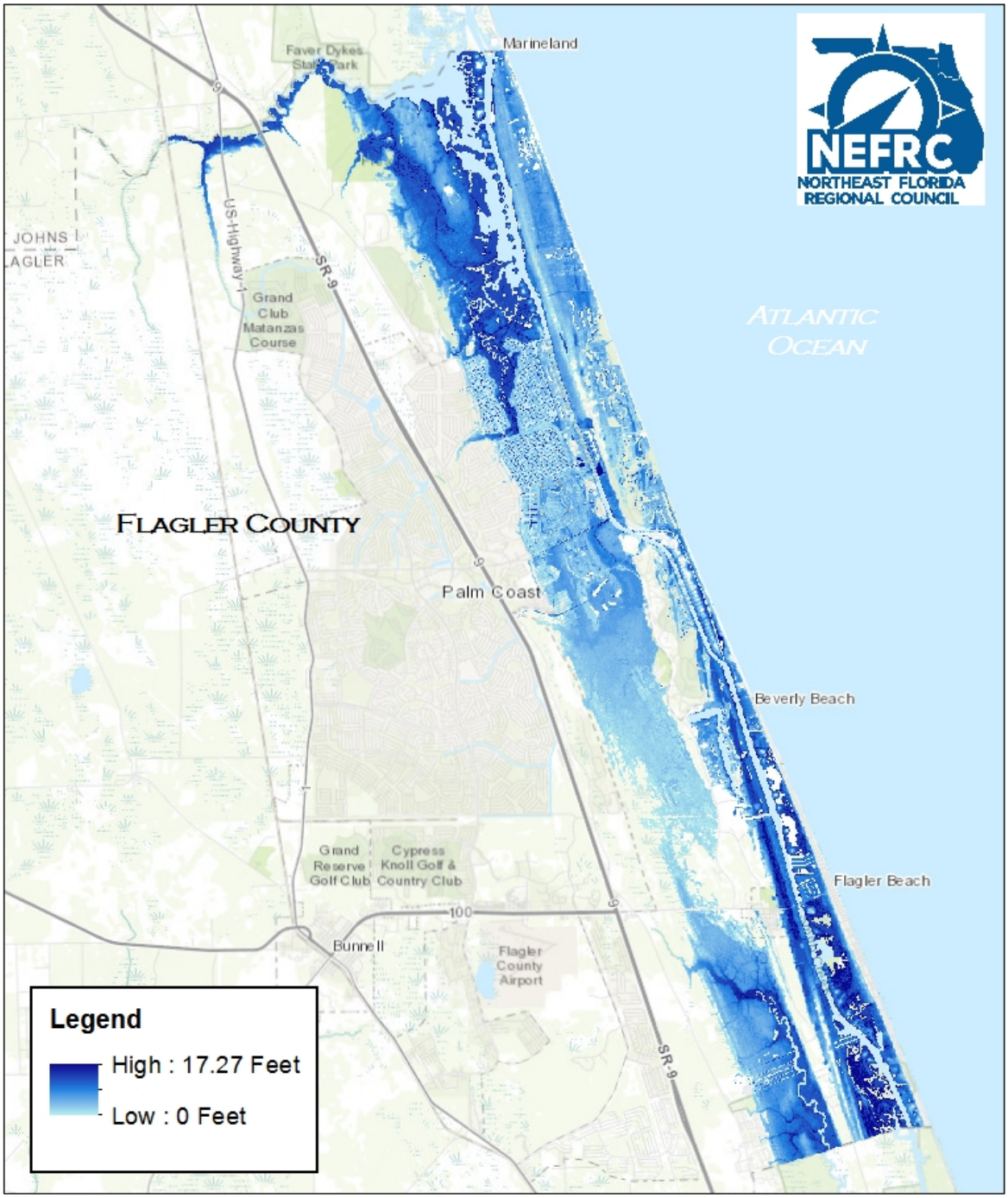
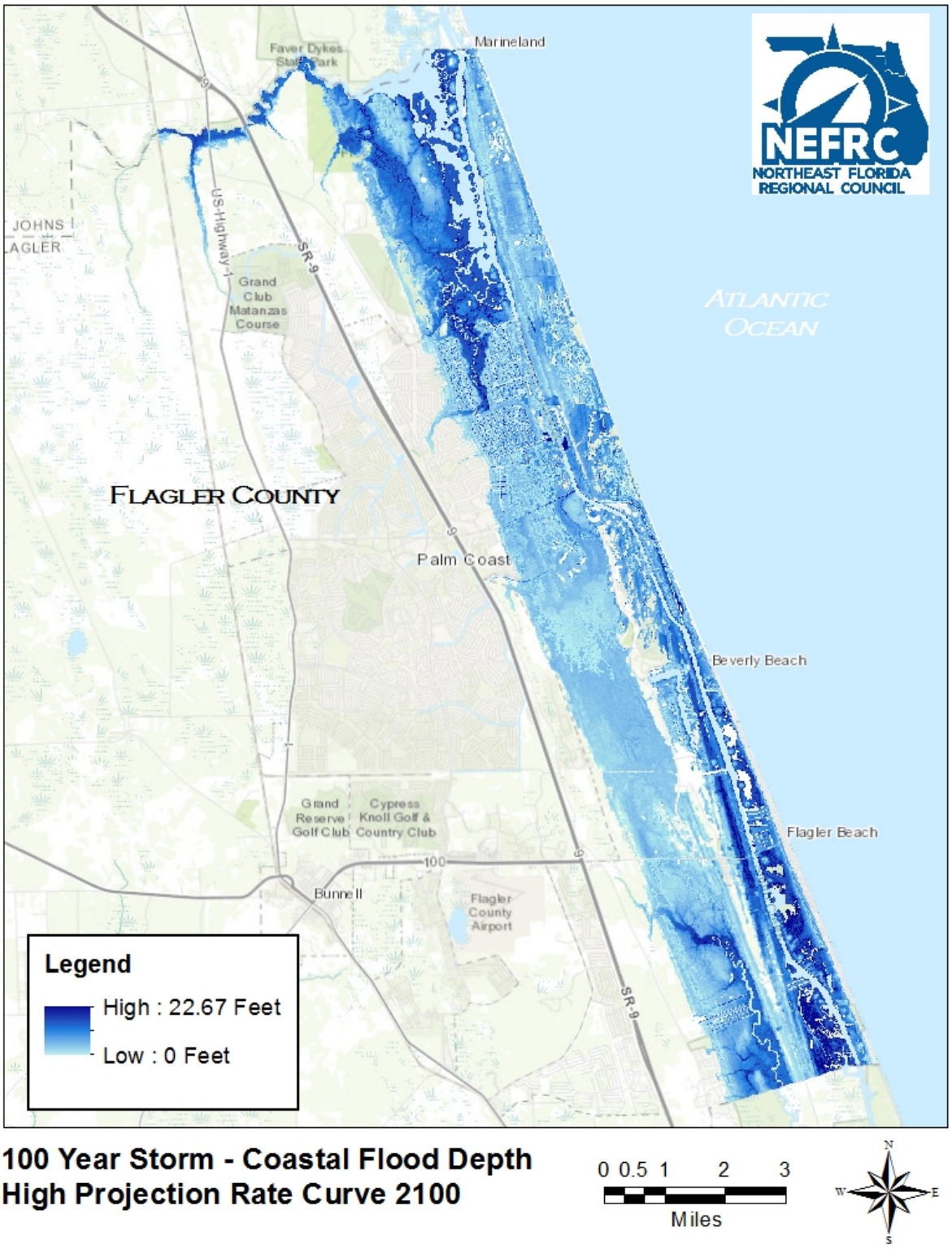


Figure 9: 100-Year Storm Coastal Flood Depth 2100 High



Significant Evacuation Routes

This section includes an analysis of significant evacuation routes that may be impacted by rising seas and mass flooding events. Evacuation routes are extremely important for the safety of residents and visitors to Flagler County in the event of an emergency or evacuation. The table below lists vulnerable evacuation routes and the total miles estimated to be flooded in each scenario. One consideration to include is that the mileage in the table below is not a solid stretch of roadway vulnerable to flooding but rather segments of that specific roadway added together for total mileage. It is recommended Flagler County further analyze the locations of these impacts to determine if larger stretches of the roadway may be mitigated due to the distance between potential impacts.

The evacuation route analysis of Flagler County estimates large impacts to State Highway/CR A1A, Palm Harbor, along with sections of State Highway 201. Along with this, we see impacts across state roads like SR 201 increasing steadily along with each scenario. The total number of miles impacted greatly increases under the high rate curve especially between 2070 and 2100 when the rate of sea level increase is highest. It is recommended Flagler begin to examine alternate evacuation routes as even under the low projection rate curve there will be at least 20 total miles of routes in Flagler potentially flooded. With many residents living on the coast and having the potential of being trapped both at their homes or unable to return to their homes after a flood event, it is important Flagler begin to take action now as many will be at risk.

Roadway Flooding in Flagler County

When: Aftermath of Hurricane Irma, September 11, 2017
Where: North 11th Street, Flagler Beach

When: Aftermath of Hurricane Irma, September 11, 2017
Where: North 6th Street, looking west toward North Flagler Ave., Flagler Beach.

Photos Courtesy of Flagler County

Table 5: Evacuation Routes Vulnerable to Coastal Flooding by Sea Level Rise Scenario

Name of Significant Road	Miles of Significant Roads Vulnerable to Coastal Flooding from 100-Year Storm Influenced by Sea Level Rise								
	Low			Intermediate			High		
	2040	2070	2100	2040	2070	2100	2040	2070	2100
Colbert Lane	< 1	< 1	< 1	< 1	< 1	< 1	< 1	2	4
County Highway 201	< 1	2	2	2	2	2	2	4	4
E State Road/Hwy 100									< 1
Farmsworth Drive			< 1		< 1	< 1	< 1	< 1	< 1
Florida Parkway Drive		< 1	< 1	< 1	< 1	2	< 1	4	4
Forest Grove Drive	< 1	< 1	< 1	< 1	< 1	< 1	< 1	1	2
Hammock Dunes Parkway	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Interstate-95	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Moody Boulevard	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
North Oceanshore Blvd	< 1	< 1	< 1	< 1	< 1	< 1	< 1	2	2
Old Dixie Highway	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Palm Coast Parkway	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Palm Coast Parkway NE	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Palm Harbor	< 1	< 1	< 1	< 1	2	4	2	5	6
State Highway 5	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
State Highway A1A	2	2	6	2	6	6	6	6	8
Surfview Drive	< 1	< 1	< 1	< 1	< 1	< 1	< 1	2	2

** The mileage has only been estimated to a whole number due to data accuracy and alignment.*

Figure 10: Evacuation Routes Vulnerable to Coastal Flooding by Low Projection Rate Curve

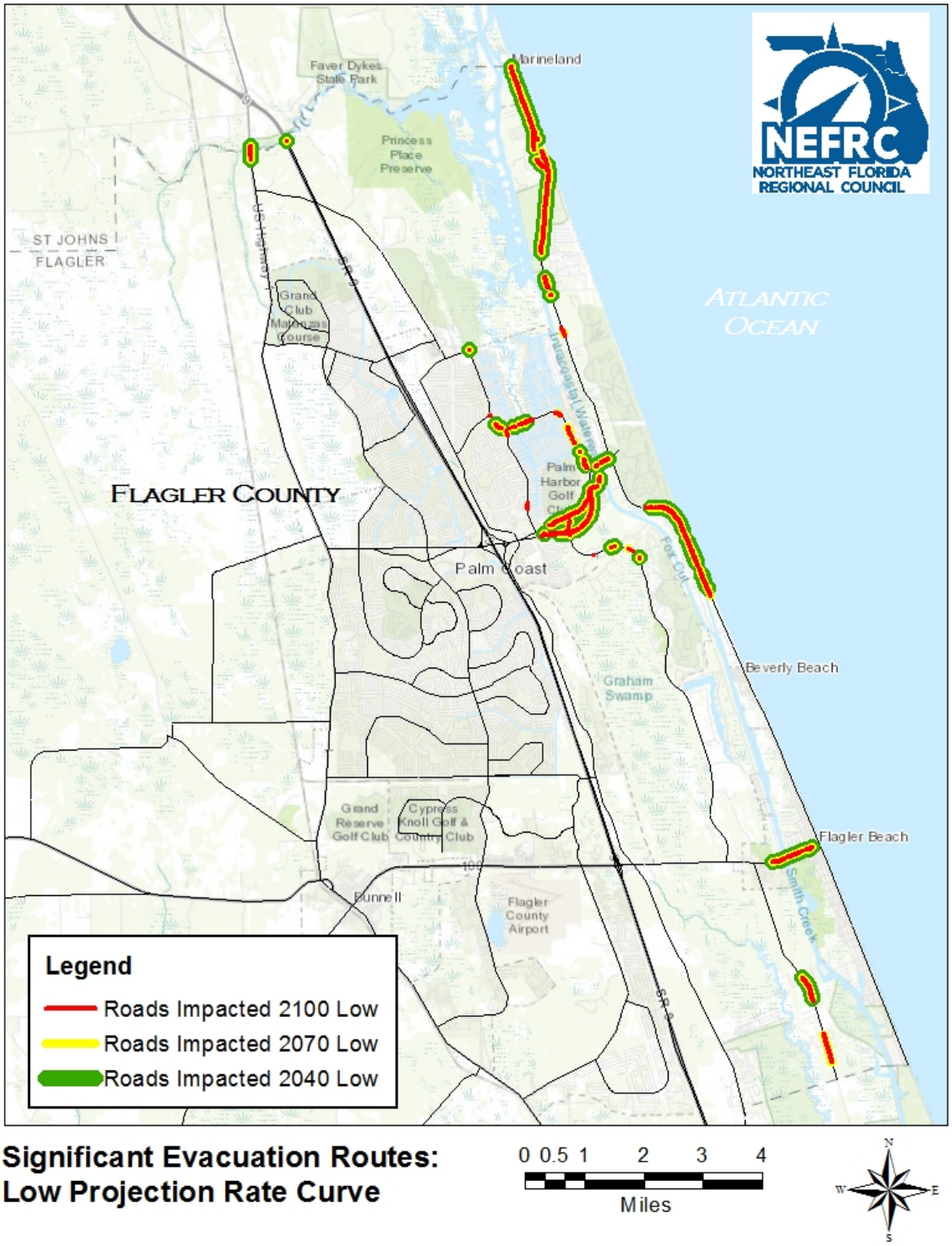


Figure 11: Evacuation Routes Vulnerable to Coastal Flooding by Intermediate Projection Rate Curve

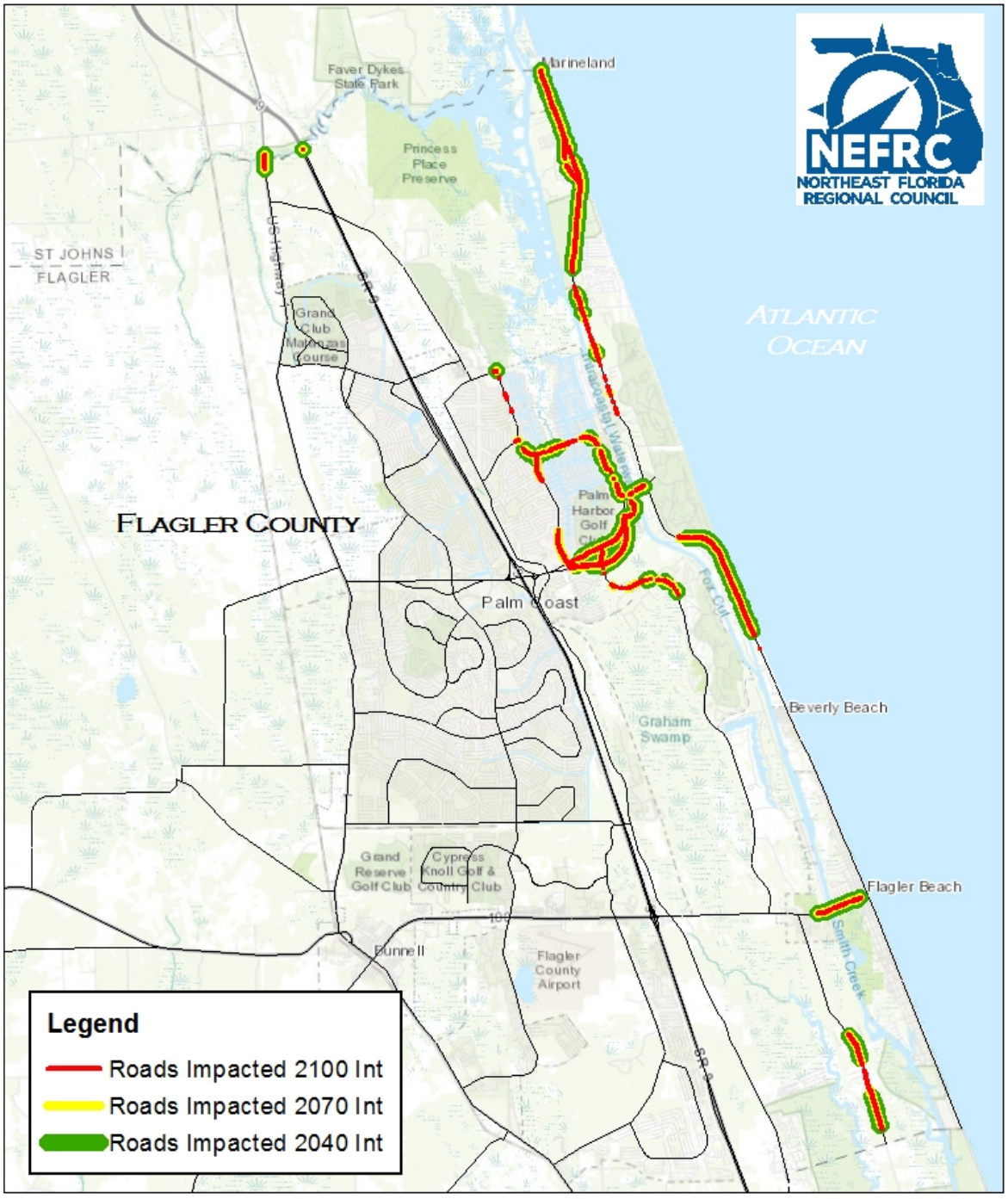
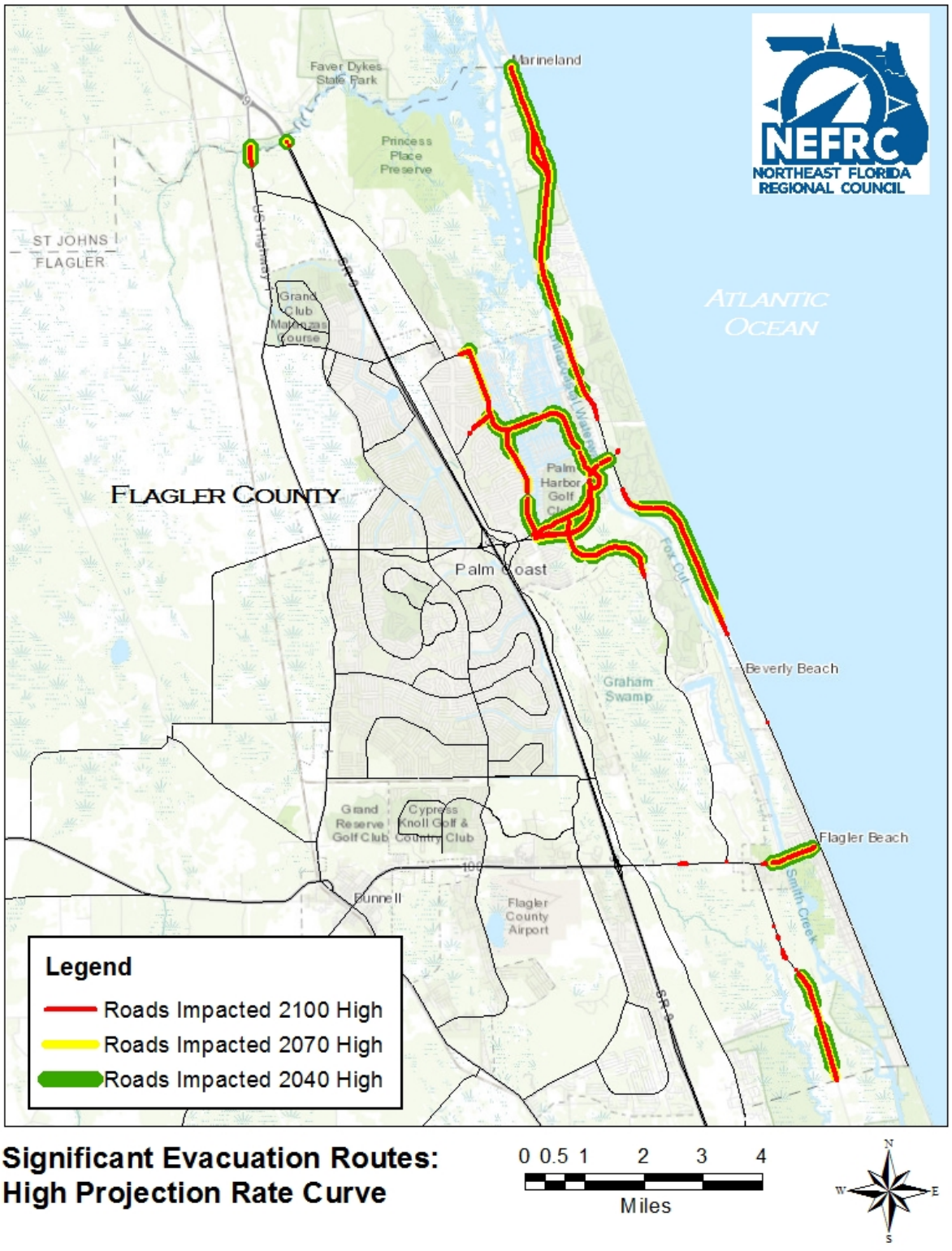


Figure 12: Evacuation Routes Vulnerable to Coastal Flooding by High Projection Rate Curve



Facilities

The impacts of coastal flooding can cause significant effects on the community economically, environmentally and socially. Access issues due to flooded roadways, facility failure, and structural issues or flooding can place a strain on the facilities' financial resources, prevent employees from earning income, and prevent some facilities from responding to community needs such as police and fire. For these reasons, it is important to address not only County and city facilities but also to educate the private sector concerning impacts and solutions. When considering adaptation strategies for facilities, consideration should be provided to life span of the facility, its purpose, and access to/from the facility due to flooding. *As noted by USACE 2014 publication, "The longer the life of engineered systems and their related socio-economic and ecological systems, the more important it becomes to evaluate, throughout the project life cycle, the sustainability and resiliency of these combined systems in the face of climate change effects."*[1] If a facility is not critical to the community during/after a storm, and access immediately after the storm is not needed, it may be deemed that some magnitude of flooding to the parcel may be acceptable. Therefore, it may be determined that only mitigation to some areas of the facility or property may be warranted to protect the facility itself. In other instances, flooding of any duration and magnitude may not be acceptable for facilities deemed critical to resiliency and recovery (i.e. wastewater treatment plants, shelters, fire/police stations, solid waste facilities). Therefore, additional analyses should be conducted such as onsite elevation data, flood risk assessment and analysis of access areas that may be vulnerable to flooding and time horizons. The most critical facilities, those likely to be impacted by 2040, should be considered a priority combined with facilities which are critical and, due to function and consequences, have a low risk tolerance.

The facility analysis includes an assessment of public works facilities, emergency management centers and other facilities that may be necessary for transportation or evacuation purposes. A complete list of facilities determined to be vulnerable to future 100-year flood levels can be found in Appendix B.

The table on the next page lists facility types, number of facilities and the scenario year they will likely be impacted by coastal flooding of a 100 – year storm. One major concern is the amount of hazardous materials facilities and wastewater and solid waste facilities that may be impacted in even the lower scenarios. It is important that these facilities are properly maintained and hazards mitigated as a failure could cause serious health and environmental issues. It may be beneficial to begin assessing facilities that may need to be relocated due to increasing frequent flooding impacts. However, some of these facilities may be small facilities with limited budgets. It is important to reach out to these businesses to discuss potential impacts to the facility and the potential of the company to conduct further analysis and risk assessment. Additionally, five fire and law enforcement stations are considered vulnerable under the high scenario. These assets are crucial in emergency responses and the stations that are predicted to be impacted should likely be assessed and possibly relocated or potentially elevated. The Post Office located on Daytona Ave. has been determined to be vulnerable by 2040 regardless of scenario, as

[1] USACE, 2014-
http://www.publications.usace.army.mil/Portals/76/Publications/EngineerTechnicalLetters/ETL_1100-2-1.pdf

well as the Beverly Beach Water Treatment Plant, and Bulow Water Treatment Plant. Finally, as future asset siting takes place, it is important that the responsible departments look at future conditions to ensure minimal risk.

Table 6: Number of Facilities Vulnerable to Coastal Flooding by Sea Level Rise Scenario

Critical Facility Type	Number of Facilities Vulnerable to Coastal Flooding from 100-Year Storm Influenced by Sea Level Rise								
	Low			Intermediate			High		
	2040	2070	2100	2040	2070	2100	2040	2070	2100
Critical Facility	5	6	7	6	7	9	7	13	16
302 Facility	2	2	2	2	3	4	3	4	4
Sheriff's Office Precinct	0	0	0	0	0	0	0	0	0
Tax Collector Satelite	0	0	0	0	0	0	0	0	0
Community Center	0	0	0	0	0	0	0	0	0
Storage	0	0	0	0	0	0	0	0	0
Agriculture/Division Forestry	0	0	0	0	0	0	0	0	0
Garage	0	0	0	0	0	0	0	0	0
Florida Forest Service	0	0	0	0	0	0	0	0	0
Office	0	0	0	0	0	0	0	0	0
Library	0	0	0	0	0	0	0	0	0
Rental Multipurpose Room	0	0	0	0	0	0	0	0	0
Water Tower	0	0	0	0	0	0	0	0	0

Table 7: Facilities Vulnerable to Coastal Flooding by Sea Level Rise Scenario

Critical Facility	Type	Facilities Vulnerable to Coastal Flooding from 100-Year Storm Influenced by Sea Level Rise								
		Low			Intermediate			High		
		2040	2070	2100	2040	2070	2100	2040	2070	2100
800 Mhz Radio Site - Flagler Beach	Critical Facility									X
Adult Education Center	Critical Facility								X	X
Bellsouth - Flagler Beach	Critical Facility	X	X	X	X	X	X	X	X	X
Bellsouth - Palm Coast #33017	Critical Facility						X		X	X
Beverly Beach Town Hall	Critical Facility									X
Beverly Beach Water Treatment Plant	302 Facility	X	X	X	X	X	X	X	X	X
Brookdale Palm Coast	Critical Facility								X	X
Bulow Water Treatment Plant	302 Facility	X	X	X	X	X	X	X	X	X
County Station 41 Fire/Rescue	Critical Facility			X		X	X	X	X	X
Daytona State College	Critical Facility		X	X	X	X	X	X	X	X
Dunes Community Development	302 Facility					X	X	X	X	X
Flagler Beach Fire/Rescue Station 11	Critical Facility	X	X	X	X	X	X	X	X	X
Flagler Beach Police Department	Critical Facility	X	X	X	X	X	X	X	X	X
Flagler Beach Wastewater Treatment Plant	302 Facility									X
Flagler County Wickline Senior Center	Critical Facility	X	X	X	X	X	X	X	X	X
Gentle Care Assisted Living Inc	Critical Facility								X	X
Grand Oaks Health & Rehabilitation Center	Critical Facility								X	X
Matanzas Shores Wastewater Treatment Plant	302 Facility						X		X	X
Palm Coast Community Center	Community Center						X		X	X
Palm Coast Station 22 Fire/Rescue	Critical Facility						X		X	X
Palm Coast Station 24 Fire/Rescue	Critical Facility									X
Post Office (Daytona Ave)	Critical Facility	X	X	X	X	X	X	X	X	X

Table 8: Facilities Vulnerable to Coastal Flooding by Depth of Flood, High Inundation Scenario

Critical Facility	Type	Depth of Flood (feet)		
		High Inundation Projection		
		2040	2070	2100
800 Mhz Radio Site - Flagler Beach	Critical Facility			0.3
Adult Education Center	Critical Facility		0.2	3.0
Bellsouth - Flagler Beach	Critical Facility	3.0	4.7	10.0
Bellsouth - Palm Coast #33017	Critical Facility		1.5	3.8
Beverly Beach Town Hall	Critical Facility			3.4
Beverly Beach Water Treatment Plant	302 Facility	1.9	3.5	8.6
Brookdale Palm Coast	Critical Facility		0.3	2.6
Bulow Water Treatment Plant	302 Facility	1.4	3.1	5.4
County Station 41 Fire/Rescue	Critical Facility	1.8	3.4	6.2
Daytona State College	Critical Facility	1.4	3.1	5.4
Dunes Community Development	302 Facility	1.5	3.2	7.6
Flagler Beach Fire/Rescue Station 11	Critical Facility	3.4	5.1	10.5
Flagler Beach Police Department	Critical Facility	5.4	7.0	12.4
Flagler Beach Wastewater Treatment Plant	302 Facility			2.0
Flagler County Wickline Senior Center	Critical Facility	4.6	6.2	11.8
Gentle Care Assisted Living Inc	Critical Facility		0.6	2.9
Grand Oaks Health & Rehabilitation Center	Critical Facility		0.7	3.0
Matanzas Shores Wastewater Treatment Plant	302 Facility		1.6	4.7
Palm Coast Community Center	Community Center		1.4	3.7
Palm Coast Station 22 Fire/Rescue	Critical Facility		1.6	3.9
Palm Coast Station 24 Fire/Rescue	Critical Facility			1.3
Post Office (Daytona Ave)	Critical Facility	1.2	2.8	8.2

Figure 13: Impacted Critical Facilities: Low Scenarios

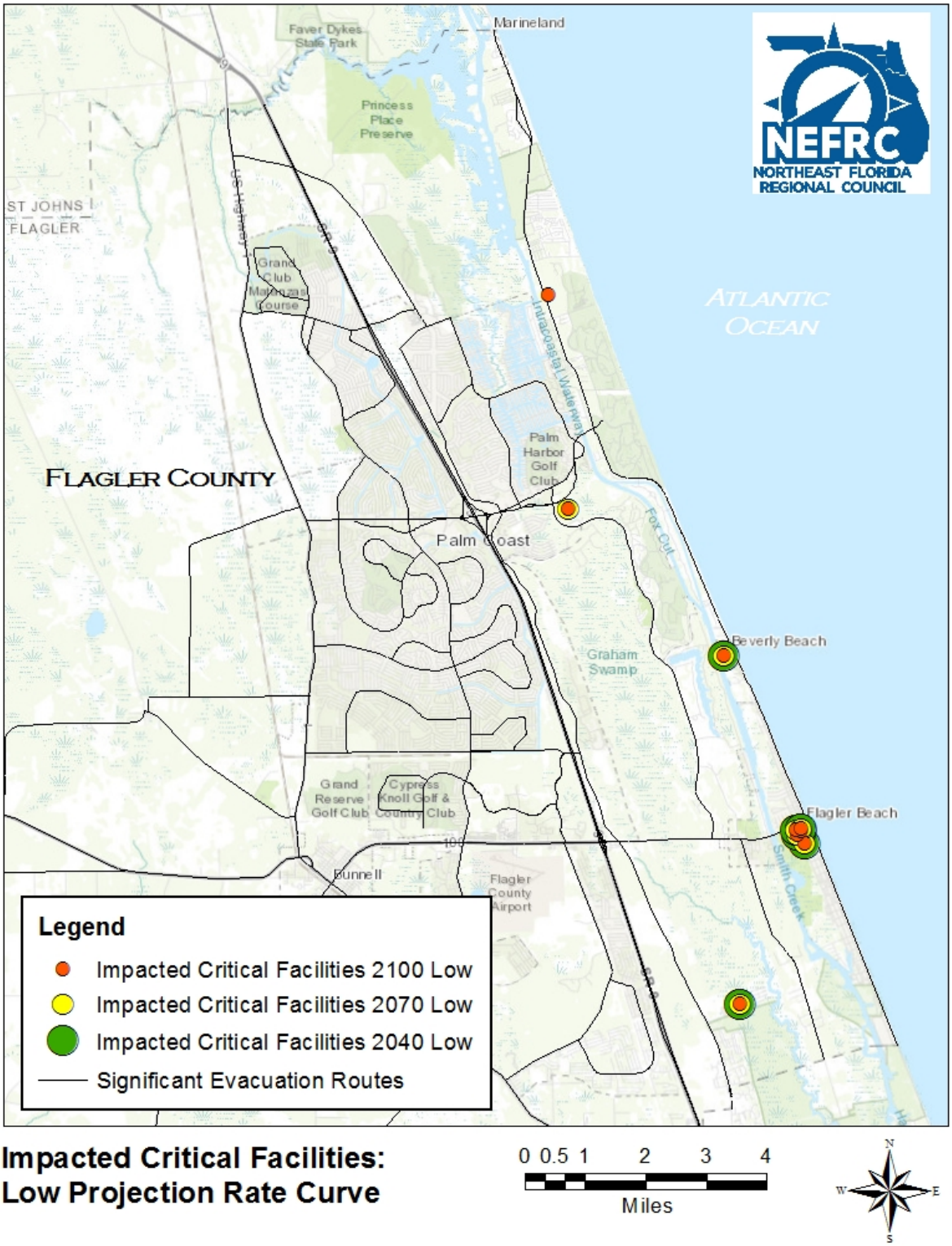
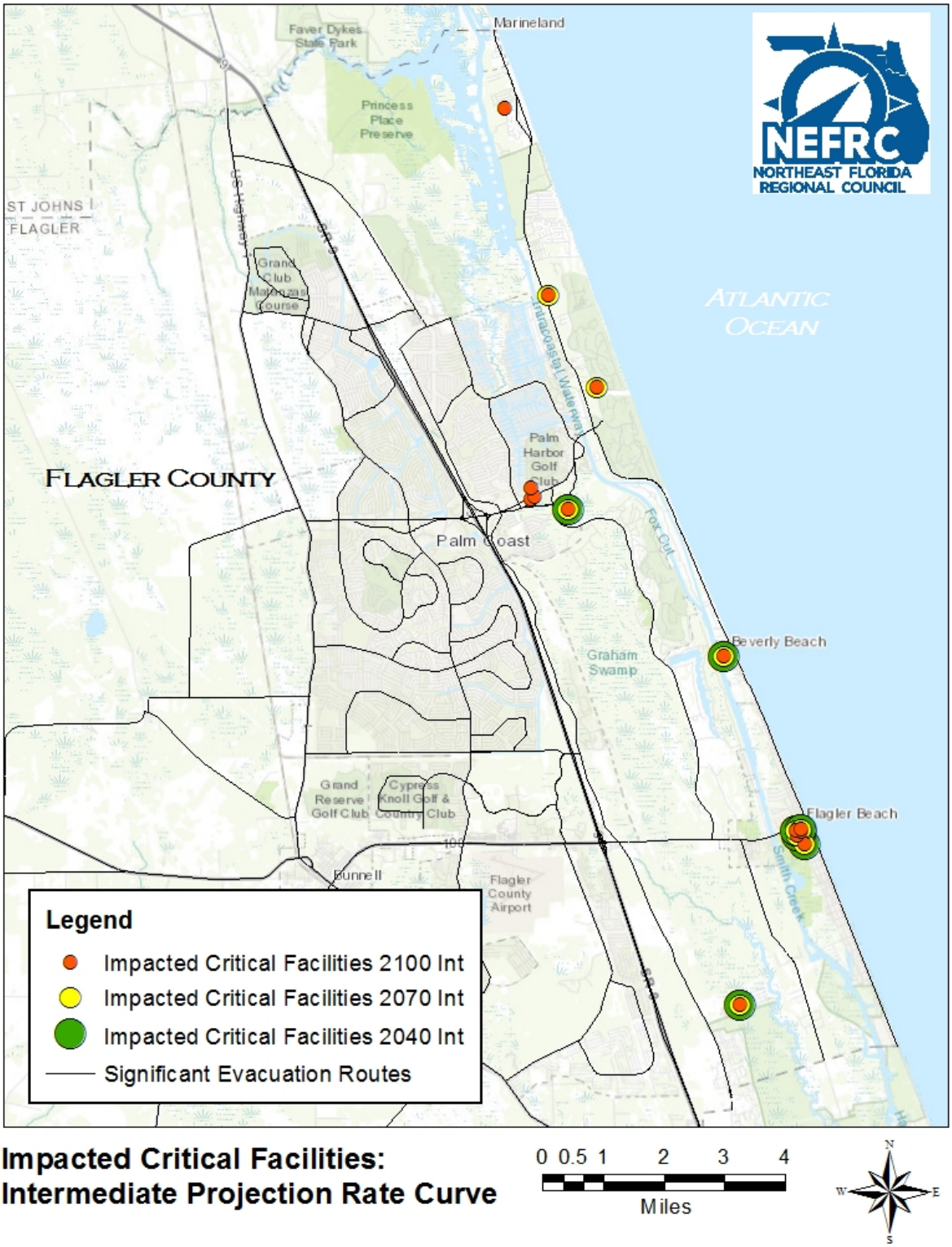
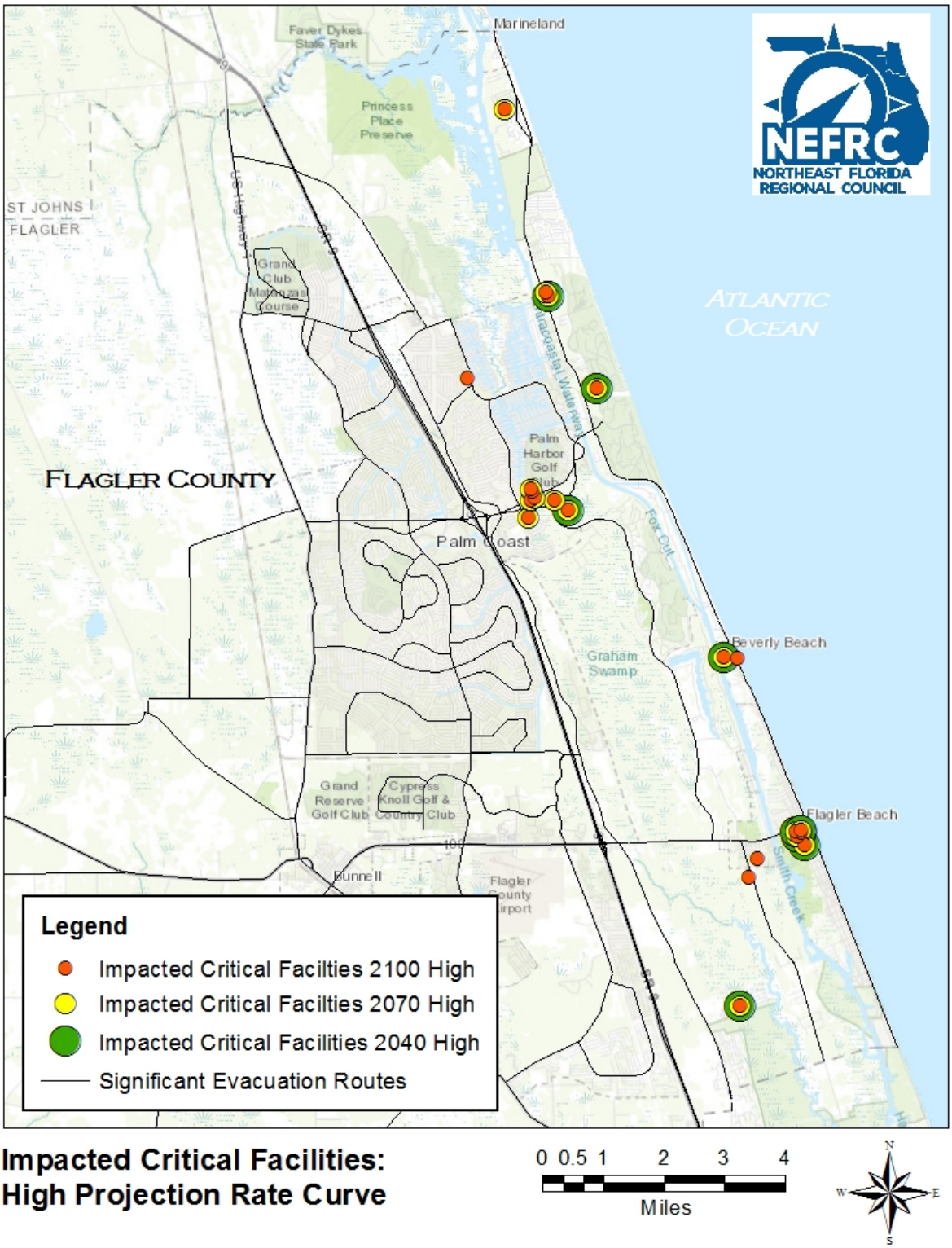


Figure 14: Impacted Critical Facilities: Intermediate Scenarios



Impacted Critical Facilities: Intermediate Projection Rate Curve

Figure 15: Impacted Critical Facilities: High Scenarios



Impacted Critical Facilities: High Projection Rate Curve

Considerations and Recommendations

There are typically three approaches when considering options in addressing vulnerabilities and risk in planning for sea level rise and incorporating strategies into various plans. [2]These three approaches are: **Accommodation, Protection, and Retreat.** Strategies and policies implemented typically fall within one of these three categories and depend on the extent and magnitude of vulnerability and risk, as well as location and purpose. Table 14 was provided by the USACE in Technical Letter 1100-21-1[3] to illustrate potential strategies that fall within each accommodation category. This is not meant to be an inclusive list of strategies but to be used as an illustration of some approaches and to be used as an aid in future discussions.

Table 9: Approaches

RETREAT: limits and discourages development in vulnerable areas and plans for relocation or removing existing structures already within the area.

ACCOMMODATION: continues development but requires new standards and regulations

PROTECTION: strategies that protect people, infrastructure and property from sea level rise impacts often implemented through engineering solutions.

Credit: Georgetown Climate, 2011

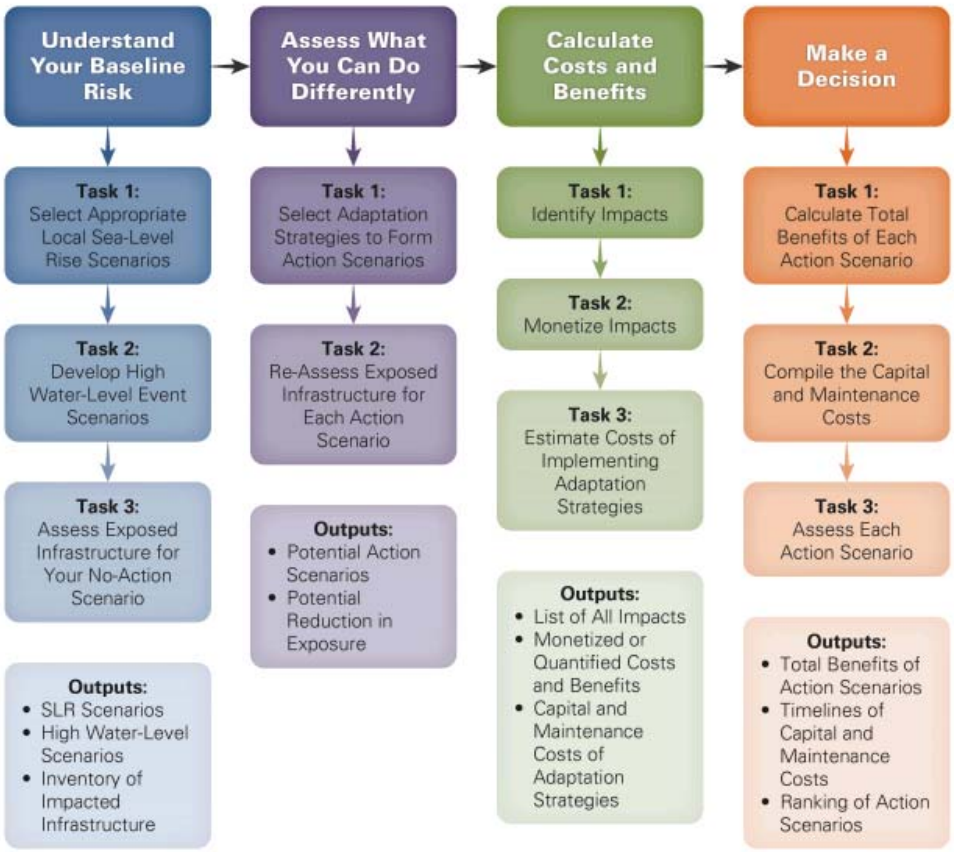
[2]Georgetown Climate, 2011 - http://www.georgetownclimate.org/files/report/Adaptation_Tool_Kit_SLR.pdf
[3] USACE, 2014-
http://www.publications.usace.army.mil/Portals/76/Publications/EngineerTechnicalLetters/ETL_1100-2-1.pdf

Table 10: Example Strategies by Adaptation Category USACE, 2014

Project Type	Protect	Accommodate	Retreat
Navigation	Upgrade and strengthen existing primary structures; Expand design footprint and cross section of existing structures, including raising for clearance and access; Add secondary structures; Add structures to protect backshore; Improve resilience of backshore facilities.	Upgrade drainage systems; Increase maintenance and dredging; Adjust channel location and dimensions; Modify operation windows; Floor proof interior infrastructure; Add sediment to shoreline or underwater morphology.	Relocate interior harbor infrastructure due to relative sea level rise or fall; Abandon harbor/port; Re-purpose project area.
Coastal Storm Damage Reduction	Upgrade and strengthen existing structures; Expand design footprint and cross section of existing structures; Add secondary structures Dune/beach construction.	Increase maintenance of shoreline protection features; Sediment management; Beach nourishment/vegetation; Upgrade drainage systems; Upgrade and modify infrastructure; Flood proof buildings; Implement building setbacks; Modify building codes.	Relocate buildings and infrastructure; Land-use planning and hazard mapping; Modify land use.
Flood Risk Reduction	Upgrade and strengthen existing structures; Expand design footprint and cross section of existing structures; Construct levees or implement flood proofing measures; Add secondary structures; Dune/beach construction.	Increase maintenance of flood risk protection features; Upgrade and modify infrastructure; Improve natural shoreline resilience (vegetation); Flood proof buildings; Implement building setbacks.	Relocate buildings and infrastructure; Land-use planning and hazard mapping; Modify land use.
Ecosystems	Construct drainage systems; Construct shoreline protection structures, dikes or cells; Construct tidal gates, install salt water intrusion barriers.	Accept changes to ecosystems; Sediment management; Change water extraction; Freshwater injection/diversion; Modify land use; Migrate landward.	Allow/facilitate habitat conversion; Forbid hard defenses; Ecosystem migration; Abandon ecosystem.

As discussed in various areas of this report, risk, probability and cost should be considered when assessing adaptation strategies. NOAA developed a report entitled *"What Will Adaptation Cost? An Economic Framework for Coastal Community Infrastructure"* in June 2013[4]. It provides a framework for communities to evaluate adaptation options for addressing resiliency. It walks through the frame work and provides meaningful appendixes that address adaptation strategies, tools and strategies for monetizing impacts and also provides relevant case studies including their methodology and findings. This report will help the various stakeholders, departments and agencies in Flagler County during "next steps" in developing a framework and action plan for the County, its municipalities, and various stakeholders. The figure below outlines the framework as presented in the NOAA report.

Figure 16: Framework Presented by NOAA for Making Informed Decisions



Source: NOAA, 2013 – https://coast.noaa.gov/data/digitalcoast/pdf/adaptation-report.pdf

Numerous other resources exist to help planners, engineers, decision makers and others develop plans, strategies and educate the public in addressing resiliency. A list of resources and tools are found in the appendix of this report. The sections that follow provide considerations as they pertain to various types of plans and potential avenues and recommendations for updating these plans.

[4] NOAA, 2013 – https://coast.noaa.gov/data/digitalcoast/pdf/adaptation-report.pdf

Emergency Preparedness

Numerous plans exist providing Flagler County with strategies, policies and goals for addressing both natural and manmade hazards. Some of these plans such as the Local Mitigation Strategy Plan (LMS) may be enhanced to include sea level rise and increased duration and extent of flooding from storms as well as increased frequency of flooding events.

The Flagler County LMS[5] is a multi-hazard and multi-jurisdictional strategy plan that establishes the broad community vision and guiding principles for reducing hazard risk and further proposes specific mitigation actions to eliminate or reduce identified vulnerabilities. The plan was updated in 2016 and has been prepared in coordination with FEMA Region IV and the Florida Division of Emergency Management to ensure that the Plan meets all applicable Disaster Mitigation Act 2000 and State requirements. The Plan includes sea level rise as a "Natural Hazard to be Researched and Monitored Further" in Section 4.11.3. This excerpt of the Plan is included as an Appendix. This analysis looked at sea level rise within a fifty year period in the range of .41 feet and 2.29 feet by 2066. It also included two HAZUS models. One did not include sea level rise, and the other added one meter of additional sea level. Both models treated the sample storm as a 100-year event. The model that included sea level rise used 3.208 additional feet of stillwater elevation on top of a 10 foot Stillwater depth and a 2 foot wave setup derived from the relevant FEMA Flood Insurance Study for Flagler County. Future versions of the LMS may be informed by the HAZUS modelling done for this study and the best available data and modelling related to sea level rise and risk at the time of the update. As noted later in this report, since the LMS is a multi-jurisdictional plan, it will be important for the County to assess and track policies and projects of local governments as they address sea level rise. Similarly, the Comprehensive Emergency Management Plan[6] was completed in 2016 to guide emergency management efforts through response and recovery. As mitigation is included in the CEMP, it too should contain consistent messaging about the potential for increased risk associated with sea level rise over time.

[5] Flagler County Website - http://www.flaglercounty.org/document_center/Emergency%20Management/LMS%202016.pdf

[6] Flagler County Website - http://www.flaglercounty.org/document_center/Emergency%20Management/CEMP%202016_BCC%20Adopted%20Plan.pdf

Photo courtesy of Flagler County, View across Lake Disston

The County will continue to consider the risks associated with sea level rise, but will also go above and beyond FEMA's National Flood Insurance Program requirements by utilizing the latest Community Rating System (CRS) Coordinator's Manual for guidance to help lower Community Rating System scores for the County and participating municipalities. New DFRIM maps for Flagler County have recently been adopted and this occasion, as well as the annual occurrence of hurricane season, provide an opportunity to highlight the community conversation needed to further education and awareness of flood risk and sea level rise.

The Community Rating System (CRS) is a national program developed by the Federal Emergency Management Agency (FEMA). The 2017 CRS Coordinator's Manual provides information on credits and credit criteria for community activities and programs are beyond the minimum requirements for participation in FEMA's National Flood Insurance Program. The CRS Manual, the Federal Emergency Management Agency (FEMA) document which establishes the details for the Community Rating System, provides a series of nineteen activities that local governments may undertake to accomplish the various goals. Communities receive credit to earn a rating of 1-10, the lower the number, the better the rating. As a result of the rating obtained from local government implementation of the activities outlined in the CRS Manual, owners of property in the participating community pay lower flood insurance premiums.

By conducting various GIS analysis, map development and assessment of sea level rise impacts, the County may utilize some of these activities for CRS credits. Also, as other forms of outreach, education and projects/policies are developed throughout the County, additional credits may also be available. It will be important to ensure appropriate criteria are met to obtain CRS credits.

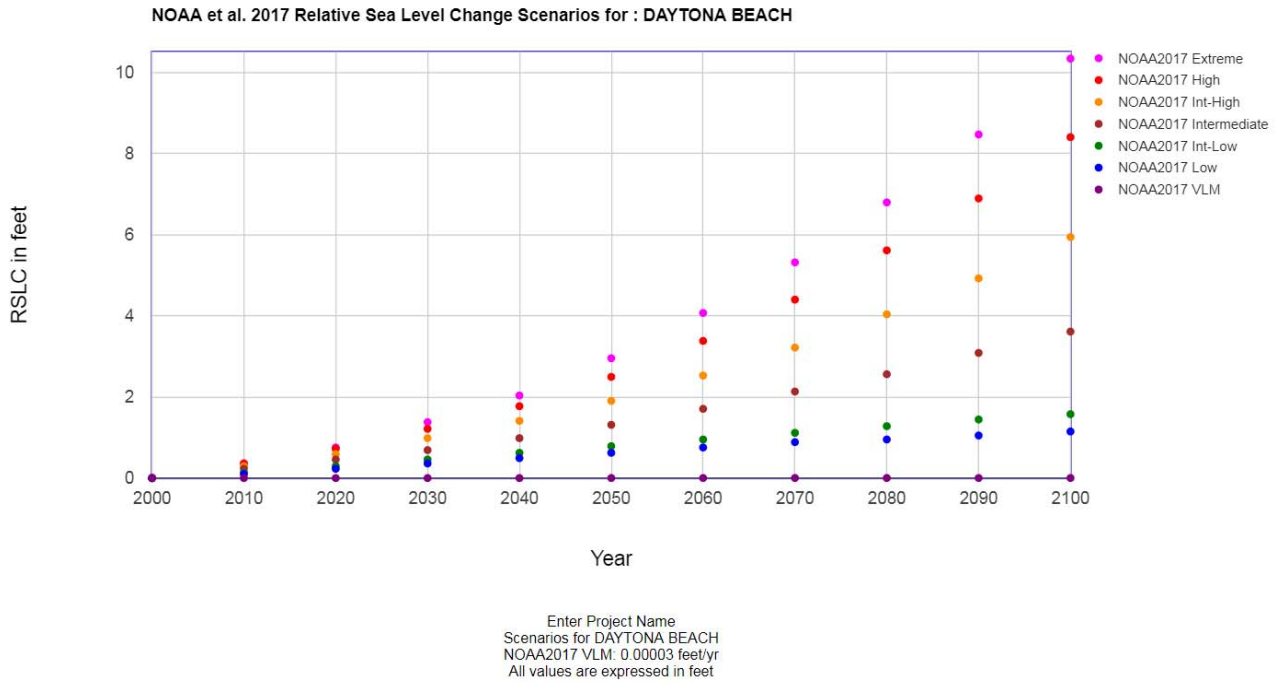
The 2017 Coordinator's Manual is available in Adobe pdf format at the FEMA NFIP website. One change included in the 2017 CRS manual is in the watershed master plan credit description to allow for the option for coastal communities to study the 2100 impact of sea level rise in lieu-of a hydrologic/hydraulic analysis of watersheds. Section 116.c. – "Future conditions and Impacts of Climate Change" discusses how the manual provides credits for these considerations. Below is information taken from this section to provide an overview of the future conditions credit[7]:

- Credit is provided in Section 322.c for communities that provide information about areas (not mapped on the FIRM) that are predicted to be susceptible to flooding in the future because of climate change or sea level rise.
- To become a Class 4 or better community, a community must (among other criteria) demonstrate that it has programs that minimize increases in future flooding.
- To achieve CRS Class 1, a community must receive credit for using regulatory flood elevations in the V and coastal A Zones that reflect future conditions, including sea level rise.
- Credit is provided in Section 342.d when prospective buyers of a property are advised of the potential for flooding due to climate changes and/or sea level rise.
- Credit is provided in Section 412.d when the community's regulatory map is based on future-conditions hydrology, including sea level rise.
- Credit is provided in Section 432.k when a community accounts for sea level rise in managing its coastal A Zones.
- Credit is provided in Section 452.a if a community's stormwater program regulates runoff from future development.
- Credit is provided in Section 452.b for a community whose watershed master plan manages future peak flows so that they do not exceed present values.
- Credit is provided in Section 452.b for a coastal community whose watershed master plan addresses the impact of sea level rise.
- Credit is provided in Section 512.a, Steps 4 and 5, for flood hazard assessment and problem analysis that address areas likely to flood and flood problems that are likely to get worse in the future, including (1) changes in floodplain development and demographics, (2) development in the watershed, and (3) climate change or sea level rise.

According to the guidance on the sea level rise projections that are to be used for the purpose of CRS credit can be found in Section 404, " The NOAA "intermediate-high" projection for 2100, as included in the report Global Sea Level Rise Scenarios for the United States National Climate Assessment (National Oceanic and Atmospheric Administration, 2012, https://scenarios.globalchange.gov/sites/default/files/NOAA_SLR_r3_0.pdf), is the minimum projection that must be used for CRS purposes. Communities may use other projections provided that they are equal to or greater to NOAA's "intermediate-high" projection for 2100." Note that NOAA updated its curves (as seen below) in 2017 and CRS references the previous report, which places the NOAA 2012 Intermediate-High Rate curve at a lower rate than the USACE high rate curve used in this report.

[7] FEMA - https://www.fema.gov/media-library-data/1493905477815-d794671adeed5beab6a6304d8ba0b207/633300_2017_CRS_Coordinators_Manual_508.pdf

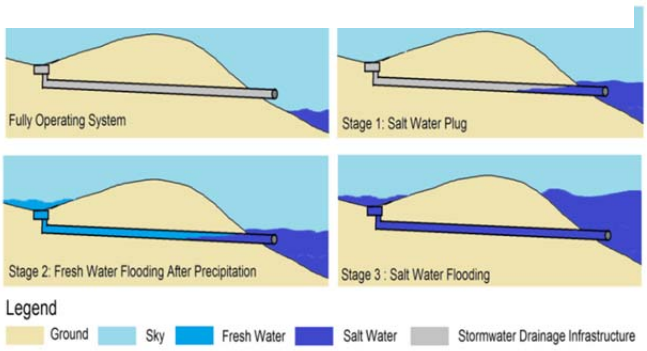
Figure 17: NOAA Relative Sea Level Changes for Daytona Beach



As one of the first signs of flooding issues is the failure of the stormwater system through backups or ponds over capacity. An important process of assessing outfalls and stormwater ponds, especially those in current and anticipated flood prone areas, should be a priority to help mitigate future impacts of increased coastal flooding. This is especially a concern in areas where stormwater pipes drain directly into coastal water bodies. Sea-level rise makes such infrastructure more susceptible to flood risk. Analysis may be necessary to determine which outfalls, though not expected to be inundated, may be susceptible to increased coastal flooding levels. The assessment and potential restructured maintenance or other mitigation efforts may not only help reduce risk during a 100-year storm but may minimize impacts from frequent flooding events, which are expected to increase in frequency as sea level rises. Assessments of stormwater infrastructure are also potential CRS credit activities. Again, care would be needed to ensure the efforts meet the criteria required for credits. Regardless, maintaining an effective and resilient stormwater system that is able to function as flooding increases and sea levels rise, is essential for a resilient community.

Additionally, green infrastructure should be emphasized in the LMS, local comprehensive plans, and long -range transportation, among others, to mitigate flooding issues. Green Infrastructure can be utilized for recreational open space while providing stormwater solutions, stormwater parks can be developed as part of larger developments or even

Figure 18: Stages of Stormwater Infrastructure Failure Due to Sea level Rise



Graphic Credit: Dr. Jason Evans, Emily Neiderman, Stetson

transportation projects. Projects are context sensitive with scale, design and multi-function purposes differing between rural, suburban and urban landscapes. Restoration of natural and living shorelines should be a priority throughout the County to help provide buffers to storm surge, especially during a 100-year storm or hurricane. The Flagler LMS should include tracking green infrastructure policies and projects as flooding mitigation projects. It is also important to educate public about green infrastructure, low impact development and living shorelines as options on private property to reduce flooding and erosion impacts, and increase their understanding of all the benefits natural infrastructure. These projects and policies may be eligible for CRS credits.

Table 15 on the following page is an excerpt from the NOAA 2013 document entitled "*What Will Adaptation Cost? An Economic Framework for Coastal Community Infrastructure"* and includes various strategies that minimize impacts associated for coastal flooding. It would be advantageous for the LMS working group to review these strategies to determine the applicability and feasibility of the implementation of some of the strategies identified, or additional strategies determined by the LMS working group or in other reports and best management practices. The Flagler LMS, given its importance, needs to be a "living document", therefore, it will be important to ensure tracking of local jurisdictional policies and strategies that are implemented as locals begin addressing impacts of sea level rise.

The Gulf of Mexico Alliance (GOMA) resiliency team developed a Resilience Index for coastal communities to self-assess a community's resiliency after a disaster. The index looks at critical infrastructure and facilities, transportation, community plans/agreements, mitigation measures, business plans and social systems. While the assessment is self-guided GOMA has trained facilitators to assist through the process. This tool may be used by the County and jurisdictions to provide an assessment of some gaps that should be addressed to increase resiliency to natural disasters and determine the community's ability to reach and maintain an acceptable level of functioning after a disaster. GOMA and UF/IFAS Extension Services are available as resources to assist in completing the index as well as other areas of technical assistance. Numerous grants and funding opportunities are also located on their website. http://www.gulfofmexicoalliance.org/

Table 11: NOAA Documented Adaptation Strategies

Adaptation Strategy	How This Adaptation Strategy Changes the Impacts of Coastal Flooding
Managed Retreat Policies	
Transfer of development rights (TDR)	Encourages future development to be located out of harm's way.
Purchase of development rights (PDR)	Encourages future development to be located out of harm's way.
Rolling easements	May discourage future development from being located in harm's way. Can lead to removal of existing development from harm's way as shorelines move inland.
Fee-simple acquisition (buyout)	Prevents new development from being located in harm's way and/or removes development currently in harm's way.
Infrastructure relocation	Relocates the infrastructure out of harm's way.
Tidal Management	
Storm-surge barriers	Prevents higher water from traveling through inlets or into estuaries up to a certain water-level increase.
Engineered Barriers	
Levees and dikes	Prevents flooding up to a certain water-level increase.
Sea walls	Prevents flooding up to a certain water-level increase.
Beach nourishment	Prevents flooding up to a certain water-level increase.
Sandbagging	Prevents flooding up to a certain water-level increase.
Infrastructure Modification/Design	
Elevated development	Reduces the damage caused by flooding by raising the infrastructure above ground level.
Flood-proofing infrastructure	Reduces the damage caused by flooding.
Floating development	Prevents flooding to structure as the development rises with the water.
Floodable development	Prevents structural damage up to a certain height. May contain some water which can prevent flooding of other assets.
Movable buildings	Allows for relocating the infrastructure out of harm's way.
Drainage systems	Manages flood water to reduce damage.
Development fees in vulnerable areas	Can be used to pay for flood mitigation measures and may encourage future development to be located out of harm's way.
Green Infrastructure	
Wetlands	Absorb water to reduce the overall water-level increase, and dissipate wave and storm surge energy.
Mangroves	Reduce the wave power, typically resulting in a smaller storm surge and a slightly lower water-level increase.
Oyster and coral reefs	Reduce the wave power, typically resulting in a smaller storm surge and a slightly lower water-level increase.
Living dunes	Prevent flooding up to a certain water-level increase.
Barrier island restoration	Reduces the wave power, typically resulting in a smaller storm surge and a slightly lower water-level increase.

Land Use Planning

As of 2018, the Flagler County comprehensive plan does not directly address sea level rise or even mention that term. It does address flooding, infrastructure and other related topics and future updates to the plan might address specifically the risks associated with sea level rise and the approaches that are supported by the County. Sections of the comprehensive plan that address flooding and standards to address or mitigate for flooding include the Capital Improvement Element, Drainage Sub-Element, and Conservation. The County has much of the base language in the comprehensive plan to address some items related to current conditions. The language may need to be expanded to include future conditions in order to continue its effort towards resiliency as conditions change.

Many resources exist to assist with this effort. In 2011, the Georgetown Climate Center developed a document titled "Adaptation Tool Kit – Sea Level Rise and Coastal Land Use". This is just one of the various documents and tools available to local governments in assessing strategies and processes to adapt to sea level rise. This particular tool kit focuses on land uses. As noted in the report, comprehensive plans are the "first step" governments can take to incorporate adaptive strategies. These policies and strategies would then lead to amendments of other ordinances such as overlays, zoning, building codes, subdivision codes, capital improvement plans, and others. The following pages include a synopsis of sea level rise adaptive tools taken from the Georgetown Climate Report to provide an overview of the various components, plans and regulations within land use planning that can be assessed for adaptation measures and policies.
(http://www.georgetownclimate.org/files/report/Adaptation_Tool_Kit_SLR.pdf)

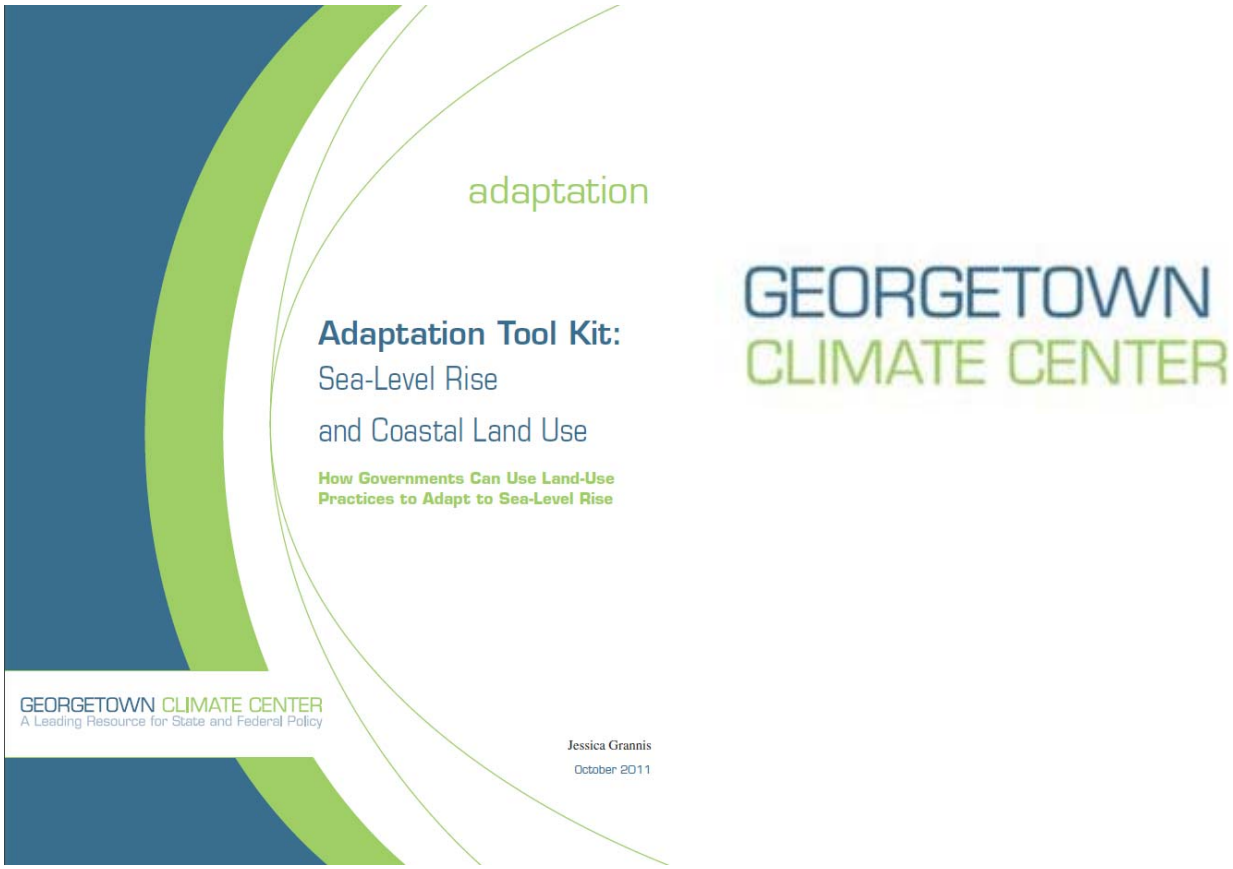


Figure 19: Synopsis of Sea Level Rise Adaptation Tools (excerpt from Georgetown Climate Center Adaptation Tool Kit)

Tool Number	Adaptation Measure	Description	Implementation to Address SLR
PLANNING TOOLS			
1	**Comprehensive Plans**	Provide the long-range planning tool used to guide future development in a community.	Considering SLR in comprehensive plans is the first step by which local governments can begin to incorporate adaptive strategies into their communities' land-use decision-making framework. Studies and evidence used to amend comprehensive plans can serve as the evidentiary support needed to amend zoning ordinances.
REGULATORY TOOLS			
2	**Zoning and Overlay Zones**	Provide the legal framework that governs the use and development of land in a community. Zoning maps divide the community into different districts based upon the types of uses that are permitted (e.g., residential, commercial, or industrial). Then, within each zone the ordinance specifies the design requirements that govern development (e.g., setbacks, building heights, building densities). Overlay zones superimpose additional regulations on an existing zone based upon special characteristics of that zone (e.g., floodplains and historic districts).	As a necessary predicate to implementing most land-use tools, local governments will need to amend their zoning ordinances to designate areas that are vulnerable to impacts and to impose special regulations on those areas. Special regulations could prohibit or limit expansion or major renovation to existing structures and rebuilding of damaged structures. Governments could create zones based upon their adaptation goals (protection, accommodation, retreat, or preservation).
3	**Floodplain Regulations**	As a requirement to participate in the National Flood Insurance Program (NFIP), local governments must impose minimum regulation on development in floodplains (generally delineated as the 100-year floodplain). Typically structures in these areas must be constructed to minimize flood damage (e.g., elevated).	Governments could impose additional restrictions on development in floodplains above NFIP minimum standards. Governments could impose use restrictions in the 100-year floodplain (e.g., limit permitted uses to low-density, large-lot residential, agricultural, or recreational uses). Governments could also begin to impose design requirements in the 500-year floodplain (e.g., requirements that structures be elevated).
4	**Building Codes and Resilient Design**	Establish requirements for building construction to maximize protection from flooding (e.g., elevation and construction techniques and materials).	Governments can extend building code regulations to properties in the 500-year floodplain and require that new structures be designed to be more resilient to flood impacts. Governments can require that structures in the 100-year coastal floodplain be further elevated or strengthened to account for increased coastal flooding from SLR over the life of the structure.

Source: Georgetown Climate Center, 2011

Tool Number	Adaptation Measure	Description	Implementation to Address SLR
5	**Setbacks/Buffers**	Require that development be set back a distance from a baseline, typically a shoreline feature (e.g., high water mark, bluff crest, or vegetative line). Require landowners to leave, in their natural state, portions of property that support natural and beneficial functions (such as wetlands that prevent runoff and flooding).	Governments could establish or increase mandatory setbacks from the coast, establish setbacks based upon projected shoreline position using calculations of increased flood and/or erosion rates, or create a tiered setback system permitting smaller structures with less of a setback and requiring greater setbacks for larger development. Governments could require that development adjacent to the shore leave buffers to provide natural protection to development while allowing for upland migration of beaches and wetlands.
6	**Conditional Development and Exactions**	Impose special conditions as a condition of a development permit. Conditions can be designed to mitigate the impacts of development, and can take the form of impact fees, land-use restrictions, and dedications of lands for public purposes.	Governments can use conditions to restrict landowners' rights to build hard coastal protection, require removal of structures that come to be inundated as the shoreline recedes, require dedication of coastal buffers, require impact fees to pay for emergency response costs or to mitigate impacts from coastal armoring, or require that structures have greater levels of flood protection.
7	**Rebuilding Restrictions**	Limit a property owner's ability to rebuild structures destroyed by natural hazards, such as flooding.	Governments can limit when and how structures are rebuilt by prohibiting reconstruction, requiring that structures be rebuilt using resilient design techniques, or conditioning redevelopment on a landowner's agreement not to armor in the future.
8	**Subdivision and Cluster Development**	Require the concentration of development in desirable areas using subdivision ordinances. These programs allow developers to increase densities in specified areas in exchange for the developer's agreement to designate open space.	Governments could encourage concentration of development in upland areas and require dedication of vulnerable areas as open-space and flood buffers.
9	**Hard-Armoring Permits**	Use permitting processes to regulate the construction of hard-engineered structures that provide flood and erosion control.	It may be necessary to harden the coast where there is considerable existing development or critical infrastructure. However, governments can limit hard armoring along vulnerable coastlines with sensitive ecosystems, require that the armoring be constructed to protect against storm surge combined with increased sea levels, and require mitigation where armoring is permitted.
10	**Soft-Armoring Permits**	Facilitate "soft" coastal protection projects that replenish or mimic natural buffers, such as beach nourishment, living shorelines, or wetlands restoration.	Governments could create permitting programs to require the use of soft-armoring techniques where feasible in order to lessen environmental impacts of shoreline armoring.
11	**Rolling Coastal Management/ Rolling Easement Statutes**	Combine different land-use regulations that serve to ensure that coastal development does not impede the natural inland migration of coastal resources.	Rolling coastal management statutes can limit new development in at-risk coastal areas, limit or prohibit the construction of hard-coastal armoring, require removal of structures that come to encroach on public lands due to erosion, and require real estate disclosures.

Tool Number	Adaptation Measure	Description	Implementation to Address SLR
SPENDING TOOLS			
12	**Capital Improvement Programs (CIPs)**	Guide future investments in public infrastructure based upon projections of the community's growth.	Governments can use CIPs to site new infrastructure out of harm's way, discontinue maintenance and repair of infrastructure that is repetitively damaged, or relocate or retrofit existing infrastructure to be more resilient to SLR.
13	**Acquisitions and Buyout Programs**	Acquire property at risk from flooding or other hazards. Structures are typically demolished and the property is restored. Undeveloped lands are conserved as open space, public parks, or for natural resources.	Governments could extend floodplain buyout programs to properties threatened from SLR and could prioritize for acquisition vulnerable properties with high natural resource value. Governments could prioritize for acquisition lands with potential to serve as flood buffers for existing development and potential to serve as corridors for migrating beaches and wetlands.
14	**Conservation Easements**	Provide a flexible mechanism by which public entities can preserve land in its natural state while allowing land to remain in private ownership. Landowners grant an easement agreeing to restrict development of the land often for compensation or tax benefits.	Governments could prioritize acquisition of easements on properties vulnerable to SLR and acquire conservation easements to ensure preservation of lands that could serve as flood buffers, habitat, or migration corridors.
15	**Rolling Conservation Easements**	Adapt conservation easements to provide a rolling boundary that is designed to preserve the ability of the shoreline to migrate inland.	Rolling easements could be used to purchase any rights that landowner may have to construct coastal armoring and to require owners to remove structures that become threatened by rising seas and erosion while allowing for some upland development of the property.
TAX AND MARKET-BASED TOOLS			
16	**Tax incentives**	Encourage preferred development patterns and can take the form of preferential assessment programs, tax abatements, and tax credits.	Governments can encourage conservation of vulnerable properties by taxing properties at a lower rate based upon its restricted "use value;" encourage relocation or retrofit of flood-prone properties by providing a one-time tax credit; or encourage upland infill development by providing tax credits or streamlined permitting.
17	**Transfer Development Rights**	Restrict development in one area ("sending area") and allow for the transfer of development rights to another area more appropriate for intense use ("receiving area").	Governments could restrict development in vulnerable areas and allow for transfer of development rights to upland parcels where development will be out of harm's way.
18	**Real Estate Disclosures**	Require sellers of real estate to disclose certain property defects to prospective buyers prior to close.	Governments can compile and disseminate information about a property's vulnerability to SLR, or require sellers to disclose if a property is located in an area vulnerable to SLR.

Specific to Florida, recent legislation has provided direct opportunities for planners to incorporate resiliency planning into local comprehensive plans. **Adaptation Action Areas (AAA)** were adopted into statute in 2011, through the Community Planning Act. Adaptation Action Areas are voluntary and help local governments adapt to coastal flooding through their comprehensive plan, by using best practices in areas such as sustainable development, green infrastructure, water management, natural resources, and post disaster redevelopment. The Florida Department of Economic Opportunity created a report entitled "Adaptation Action Areas: A Planning Guidebook for Florida's Local Governments". The report provides a process to help guide local governments in integrating Adaptation Action Areas into various planning and operational documents and procedures. The guidebook includes a "broad process for engaging community stakeholders, identifying vulnerability, developing planning tools, adopting policies, and implementing strategies." [8] Also included are local lessons learned as AAAs will not be identical across jurisdictional lines. What may work in one community may not be suitable for another. It is important to remember that the main purpose of an AAA, according to Section 163.3164 (1) of Florida State Statute is to prioritize funding for infrastructure and adaptation planning.

> *"Adaptation Action Area" or "Adaptation Area" is an optional designation in the coastal management element of a local government's comprehensive plan which identifies one or more areas that experience coastal flooding due to extreme high tides and storm surge, and that are vulnerable to the related impacts of rising sea levels* ***for the purpose of prioritizing funding for infrastructure needs and adaptation planning****. Section 163.3164(1), Florida Statute*

In 2015, Florida Senate passed SB 1095 and the House passed HJ 803 resulting in the **Peril of Flood Act**, approved by the Governor (https://www.flsenate.gov/Session/Bill/2015/1094/?Tab=BillHistory). The act specifies requirements for jurisdictions required to have a coastal management element in their comprehensive plan. The Act requires the coastal management redevelopment element to:

1) Include development and redevelopment principles, strategies, and engineering solutions that reduce flood risk in coastal areas which results from high-tide events, storm surge, flash floods, storm water runoff, and the related impacts of sea level rise.
2) Encourage the use of best practices development and redevelopment principles, strategies and engineering solutions that will result in the removal of coastal real property from flood zone designations established by FEMA.
3) Identify site development techniques and best practices that may reduce losses due to flooding and claims made under flood insurance policies issued in this state.

[8] Florida Department of Economic Opportunity, 2015 - http://www.floridajobs.org/docs/default-source/2015-community-development/community-planning/crdp/aaaguidebook2015.pdf?sfvrsn=2

4) Be consistent with, or more stringent from, the flood-resistant construction requirements in the Florida Building Code and applicable flood plain management regulations set forth in 44 C.F.R part 60.
5) Require that any construction activities seaward of the coastal construction control lines established pursuant to s. 161.053 be consistent with chapter 161.
6) Encourage local governments to participate in the FMA CRS program to achieve flood insurance premium discounts for residents.

As the County and municipalities adopt Peril of Flood revisions to the Comprehensive Plan, and consider adaptation action areas as a strategy, where appropriate, staff should evaluate and incorporate these concepts, strategies, and principles into other plans including:

- Capital Improvement Plans
- Resiliency Plans
- Sustainability Plans
- Emergency Management Plans
- Local Mitigation Strategy
- Stormwater Master Plans
- Park and Trail Plans/Conservation Plans
- Transportation Plans
- Strategic Plans
- Land Development Regulations
- Agreements with utility and infrastructure providers
- Agreements with Public Health Providers
- Other local government agreements
- Other government plans and procedures

It is important that all these plans align, so that the County's assumptions and strategies are clear, and the message to the public is consistent.

Understanding only where inundation will occur, combined with increased periodic flooding, only gives one piece of the story. Sea level rise will create a new landscape in Flagler County through ecosystem changes and migrations. As ecosystems change and move, wetlands migrate and new systems develop, connectivity between ecosystems, conservation lands and uplands will need to be re-examined. Current development plans may hinder migration of wetlands and the natural progression of ecosystem connectivity. Examining anticipated ecosystem migration, compared to existing and future land use and current conservation plans is critical in determining adaptation strategies, land use decisions, and policy development.

Transportation Planning

Many of the resources and strategies presented previously can easily be incorporated into transportation planning. The main plan for transportation planners is the Long-Range Transportation Plan (LRTP). This plan, as with the comprehensive plan and emergency management plans, should incorporate scenarios and sea level rise ranges on which to base planning and decision making. The River to Sea TPO has already conducted a preliminary assessment on vulnerable transportation infrastructure using the same sea level rise scenarios within this report. The findings of that report should be combined with those of this analysis to develop areas of priority. Policies and procedures for incorporating those priority areas and sea level rise into studies associated with new roadways or improvements should be incorporated into the long-range transportation plan. Some considerations should include roadways that may not be susceptible to sea level rise but may be subsequently undercut with erosion due to rising seas and increased wave action; roadways near stormwater ponds that are already over capacity during storms or are within the areas anticipated to be inundated or within potential new flood areas; bridge run ups should be further analyzed to determine impacts as these areas are sometimes difficult to model using lidar/DEM data, additionally, bridge span above water levels should also be assessed. Green infrastructure is a concept that should be considered for projects within current or anticipated flood areas. These projects can help mitigation future flood impacts and provide numerous environmental and social benefits.

One of the necessary steps in order to build the consensus around these new policies and procedures is to engage the elected officials and staff who are working to make decisions and implement the strategies. The River to Sea TPO is off to a great start in building consensus and educating stakeholders, implementers and decisions makers. The Annual Retreat of the TPO held early in 2017 focused on sea level rise, stormwater impacts and how to plan for the vulnerabilities and legal issues that may arise as the counties address rising seas.

Funding for roadway improvements are often tied to federal standards and requirements. It will be important to make sure policies, procedures and plans of the FDOT, TPO and County are in line with the requirements of the federal agencies to ensure compliance to receive funding. Contractors should also be aware of new standards and processes to ensure timely deliverables that address the needs associated with new procedures and engineering solutions required under funding agencies. Reviewing the funding regulations and updating plans and procedures are important next steps for the TPO, FDOT and County.

The Federal Highway Administration has been hosting a number of webinar series addressing resiliency in transportation. These webinars are still available and cover topics including:

- Pilot Projects
- How to assess assets and vulnerabilities to sea level rise and storm surge
- Green infrastructure for transportation resiliency
- Overview of tools including the Vulnerability Assessment Scoring Tool (VAST)
- Engineering Roads and Assets to be resilient to climate change
- And many others

The webinars can be viewed at the following link:

https://www.fhwa.dot.gov/environment/sustainability/resilience/webinars/index.cfm

Conclusion

All county and city planning areas are intertwined and strategies incorporated in any area will have either benefits or consequences, including economic implications, in other realms. For example, impacts on transportation facilities also have economic and social impacts. It is important for Flagler County to continue its cross departmental, agency and jurisdictional conversations. The stakeholders group established for Resilient Flagler may be a place to start. A working group with a regular meeting schedule to share experiences and assure aligned efforts is one possibility. Even if this is not an immediate approach, the various jurisdictions and departments within the County should share drafts of their updates to plans when they are in any way related to resiliency, to ensure that efforts are aligned and the message to the community is consistent.

Flagler County and the stakeholder group should consider the implementation of Adaptation Action Areas in the comprehensive plan to identify, plan for and strategize funding for vulnerable infrastructure projects. Consideration should also include Florida SB 1094, "An Act relating to the peril of flood" which incorporates sea level rise as a flood risk when addressing development and redevelopment principles. Further analysis of the stormwater system including outfalls and stormwater ponds should be conducted to assist in the prioritizing of infrastructure improvements or mitigation projects. The Flagler County LMS should further enhance its commitment to address sea level rise and the increase for potential flooding and track member jurisdictions' policies in order to apply for CRS Credits, as well as the actions of the TPO. The County should closely follow the upcoming NFIP structure discussions. Finally, the TPO should begin to implement strategies and procedures into their various plans including the long-range transportation plan and the prioritization process. The County and municipalities should be at the table with the TPO during these discussions so that similar strategies and planning criteria may be incorporated into the planning for local and county roadways.

Additionally, a review of conservation areas, planned acquisition and other open space through the lens of resiliency may open opportunities for ecosystem migration, provide green infrastructure for stormwater mitigation, and provide social and economic benefits while protection life and property. A large undertaking of understanding risk and probability associated with future conditions is also a recognized next step for county departments. As mentioned in this report, mitigation efforts, retrofits, relocation and other strategies may need to be assessed upon cost benefit, risk analysis to aid in the decision-making process. This may be necessary for large scale, costly projects. This planning effort acknowledges that maintenance of existing facilities may be limited to what can be done in existing footprints or right of way, and encourages creative and innovative approaches to increase resiliency within those constraints. It is encouraged to design new projects with the benefit of an infrastructure checklist such as that provided by the Northeast Florida Regional Council[9], and to scope them in the context of a cost benefit analysis (see footnote #7) that takes into account the full range of factors, including the intended use, the vulnerability of the site and the anticipated lifespan of the improvement.

[9] NEFRC Website - http://www.rcinef.org/Infrastructure_Checklist_Form.pdf

It is important to remember the ever-changing science behind sea level rise. During the writing of this report, FEMA released its “non-regulatory data” that shows where flood zones have changed, adds one, two and three feet of sea level rise to flood maps, and identifies the predicted depth of flooding. These resources help the County, its municipalities, resident and businesses to better understand their risk. The County recently had lidar data run for the County, and this too provides site specific data that can help planners site infrastructure appropriately and help engineers design it resiliently. As stated previously, the 2017 CRS manual contains a requirement to use at a minimum the NOAA intermediate high projection (2012) for future conditions when addressing sea level rise. While analysis to date has considered the USACE, the USACE high projection rate curve is higher than the 2012 NOAA intermediate-high rate curve. When new infrastructure is considered, based on the anticipated lifespan of the improvement, it is recommended to consider the USACE High projection rate curve as that complies with the 2017 CRS, making it easier for affected community as they seek CRS points.

As the County and agencies discuss the adoption of a projection curve, it is important to remember that, no matter which scenarios one might choose, it is essential to think about risk tolerance for different types of assets to determine the appropriate curve for planning. The County may ultimately choose a range between curves, such as High and Intermediate based on risk and type of infrastructure.

Acronyms	
AAA	Adaptation Action Areas
CBP	Custom and Border Protection
CPI	FDEP Coastal Partnership Initiative
CRS	Community Rating System
DEM	Digital Elevation Model
NEFRC	Northeast Florida Regional Council
FDEM	Florida Department of Emergency Management
FDEO	Florida Department of Economic Opportunity
FDEP	Florida Department of Environmental Protection
FDOT	Florida Department of Transportation
FEC	Florida East Coast Railway
FEMA	Federal Emergency Management Administration
FHWA	Federal Highway Administration
FIS	Flood Insurance Study
FMP	Floodplain Management Plan
FPZA	Florida Planning and Zoning Association
GIS	Geographical Information Systems
GOMA	Gulf of Mexico Alliance
Hazus-MS	Multi-Hazard Loss Estimation Methodology
IFAS	University of Florida's Institute of Food and Agricultural Sciences
Lidar	Light Detection and Ranging
LLC	Limited Liability Corporation
LMS	Local Mitigation Strategy
LRTP	Long Range Transportation Plan
MHP	Mobile Home Park
MSL	Mean Sea Level
NASA	National Aeronautics and Space Administration
NAVD88	North American Vertical Datum of 1988
NFIP	National Flood Insurance Program
NOAA	National Oceanographic and Atmospheric Administration
POFA	Peril of Flood Act
R2CTPO	River to Sea Transportation Planning Organization
RSLR	Relative to Mean Sea Level Rise
SLR	Sea Level Rise
SME	Subject Matter Experts
SWD	Stillwater Depth
SWEL	Stillwater Elevation
TPO	Transportation Planning Organization
USACE	United States Army Corps of Engineers
WWTF	Waste Water Treatment Plant

RESILIENT FLAGLER

APPENDICES

Appendix Table of Contents

APPENDIX A

Resilient Volusia County Stakeholder List

Resilient Volusia County Stakeholder Contact List

Name	Agency	Phone	Email
Adam Mengel	Flagler County	386-313-4045	amengel@flaglercounty.org ;
Al Hill	Volusia County	386-736-5973, ext. 13470	ahill@volusia.org;
Alex Blake	Palm Coast	386-986-2515	ablake@palmcoastgov.com ;
Brian Matthews	Palm Coast	386-986-2353	bmatthews@palmcoastgov.com;
Colleen Nicoulin	River to Sea TPO	386-226-0422, ext. 20417	cnicoulin@r2ctpo.org ;
Crystal Goodison	UF Geoplan	352-392-2351	goody@geoplan.ufl.edu;
Darlene Pardiny	Flagler County	386-313-4274	
Denise Bevan	Palm Coast	386-986-3700	dbevan@palmcoastgov.com;
Faith Alkhatib	Flagler County	386-313-4045	falkhatib@flaglercounty.org;
Fred Griffith	Bunnell	386-437-7500	fgriffith@bunnellcity.us;
Fred Milch	ECFRPC	407-262-7772	fmilch@ecfrpc.org ;
Heather Garcia	FDOT	386-943-5077	heather.garcia@dot.state.fl.us ;
Jay Anderson	FDEM	386-853-0321	Jay.anderson@em.myflorida.com;
Joe Duncan	FDOT	386-943-5000	joe.duncan@dot.state.fl.us;
Jon Cheney	Volusia County	386-736-5968	jcheney@co.volusia.fl.us;
Jonathan Lord	Flagler County	386-313-4000	jlord@flaglercounty.org;
Jordan Myers	Palm Coast	386-986-2320	jmyers@palmcoastgov.com ;
Jose Papa	Palm Coast	386-986-5469	jpapa@palmcoastgov.com;
Katrina Locke	Volusia County	386-736-2700	klocke@volusia.org;
Kay McNeely	Flagler Beach	386-517-2000x248	kmcneely@cityofflaglerbeach.com ;
Larry LaHue	Volusia County	386-756-5980	llahue@volusia.org;
Larry Newsome	Flagler Beach	386-517-2000	lnewsom@cityofflaglerbeach.com;
Laura Nelson	Flagler County	386-313-4000	lnelson@flaglercounty.org;
Lois Bollenback	River to Sea TPO	386-226-0422, ext. 20419	lbollenback@r2ctpo.org;
Margo Moehring	Northeast Fl Regional Council	904-279-0885, ext. 161	mmoehring@nefrc.org;
Mary Kronenberg	Palm Coast	386-986-2306	mkronenberg@palmcoastgov.com ;
Mike Brennan	Palm Coast	386-986-3700	mbrennan@palmcoastgov.com;
Mike Peel	Palm Coast	386-986-3700	mpeel@palmcoastgov.com;
Perry Mitrano	City of Bunnell	386-437-7500	pmitrano@bunnellcity.us ;
PJ Smith	ECFRPC	407-262-7772	pjsmith@ecfrpc.org ;
Ray Tyner	Palm Coast	386-986-3700	rtyner@palmcoastgov.com;
Stephan Harris	River to Sea TPO	386-226-0422, Ext. 20428	sharris@r2ctpo.org;
Stephen Emmett	Beverly Beach	386-439-3527	wayne_emmett@yahoo.com ;
Tara McCue	ECFRPC	407-262-7772	tara@ecfrpc.org;
Thomas Rupert	Sea Grant		truppert@ufl.edu;
Tim Telfer	Flagler County	386-313-4000	ttelfer@flaglercounty.org;
Vickie Wyche	FDOT	386-943-5185	vickie.wyche@dot.state.fl.us;

APPENDIX B

List of Critical Facilities

Critical Facilities – All

Critical Facility	Type
800 Mhz Radio Site - Cody's Corner	Critical Facility
800 Mhz Radio Site - Eoc	Critical Facility
800 Mhz Radio Site - Espanola	Critical Facility
800 Mhz Radio Site - Flagler Beach	Critical Facility
800 Mhz Radio Site - Matanzas	Critical Facility
800 Mhz Radio Site - Sheriff'S Office	Critical Facility
Adult Education Center	Critical Facility
Alternate Home Care Specialist	Critical Facility
Anna's TLC	Critical Facility
Automated Weather Observation System - New	Critical Facility
Bellsouth - Bunnell	Critical Facility
Bellsouth - Flagler Beach	Critical Facility
Bellsouth - Palm Coast #33017	Critical Facility
Beverly Beach Town Hall	Critical Facility
Beverly Beach Water Treatment Plant	302 Facility
Brendlyn Assisted Living Llc	Critical Facility
Brookdale Palm Coast	Critical Facility
Bulow Water Treatment Plant	302 Facility
Bunnell City Hall And Police Department	Critical Facility
Bunnell Station 62 Fire/Rescue	Critical Facility
Bunnell Wastewater Treatment Plant	302 Facility
Bunnell Water Treatment Plant	302 Facility
Carmela's Cottage Lls	Critical Facility
Church, School & Offices	Critical Facility
City Walk Commercial Condo	Sheriff’s Office Precinct
Coastal Comfort	Critical Facility
Concord Loving Care #2	Critical Facility
Concord Loving Care Inc	Critical Facility
Country Cottage Living Center	Critical Facility
County Station 31 Fire/Rescue	Critical Facility
County Station 41 Fire/Rescue	Critical Facility
County Station 51 Fire/Rescue	Critical Facility
County Station 71 Fire/Rescue	Critical Facility
County Station 81 Fire/Rescue	Critical Facility
County Station 92 Fire/Rescue	Critical Facility

Critical Facility	Type
County Tax & Tag	Tax Collector Satellite
David I. Siegel Adult Day Care Center	Critical Facility
Daytona State College	Critical Facility
Devindale Inc	Critical Facility
Dunes Community Development	302 Facility
Espanola Community Center	Community Center
Fire/Ems Storage	Storage
Fireflight Operations Hanger	Critical Facility
Flag Co Ag Centerpreviously Shelter For Ag Animals	Critical Facility
Flagler Beach City Hall	Critical Facility
Flagler Beach Fire/Rescue Station 11	Critical Facility
Flagler Beach Police Department	Critical Facility
Flagler Beach Wastewater Treatment Plant	302 Facility
Flagler Beach Water Treatment Plant	302 Facility
Flagler County Emergency Operations Center	Critical Facility
Flagler County Energy	Critical Facility
Flagler County Government Service Building	Critical Facility
Flagler County Health Department	Critical Facility
Flagler County Hqtrs	Tiitf/Agr -Div Forestry
Flagler County Humane Society	Critical Facility
Flagler County Inmate Facility	Critical Facility
Flagler County Sheriff's Operations Center	Critical Facility
Flagler County Wickline Senior Center	Critical Facility
Flagler Health And Rehabilitation Center	Critical Facility
Fleet Garage	Garage
Florida Forest Service	Florida Forest Service
Florida Hospital Flagler	Critical Facility
Fountain Manor	Critical Facility
General Services	Office
Gentle Care Assisted Living Inc	Critical Facility
Gentle Care Assisted Living Inc Ii	Critical Facility
Gerdie Health Provider Inc	Critical Facility
Golden House Senior Living	Critical Facility
Good Samaritan Care Center	Critical Facility
Grand Oaks Health & Rehabilitation Center	Critical Facility
Guardian Home Care	Critical Facility

Critical Facility	Type
Happy Days Assisted Living	Critical Facility
Home Depot	302 Facility
Home Sweet Home Of Palm Coast Inc	Critical Facility
Imagine School	Critical Facility
Kanthal - Palm Coast	302 Facility
Kim C Hammond Judicial Center	Critical Facility
Las Palmas Retirement Residence	Critical Facility
Lexelle Assisted Living Facility Inc	Critical Facility
Lexelle Assisted Living Facility Inc	Critical Facility
Library	Library
Loving Angels Assisted Living Inc	Critical Facility
Loving Home Of Palm Coast	Critical Facility
M H Tender Care Iii	Critical Facility
M H Tender Care Inc	Critical Facility
M H Tender Care Iv	Critical Facility
Magnolia Manor Of Palm Coast	Critical Facility
Magnolia Manor Of Palm Coast Inc.	Critical Facility
Matanzas Shores Wastewater Treatment Plant	302 Facility
Medical Offices In Hospital	Critical Facility
Ness Extended Family Home Care Inc	Critical Facility
Old City Hall	Rental Multipurpose Room
Olivette Home Care	Critical Facility
Palm Coast City Hall	Critical Facility
Palm Coast Community Center	Community Center
Palm Coast Station 21 Fire/Rescue	Critical Facility
Palm Coast Station 22 Fire/Rescue	Critical Facility
Palm Coast Station 23	Critical Facility
Palm Coast Station 24 Fire/Rescue	Critical Facility
Palm Coast Station 25 Fire/Rescue	Critical Facility
Palm Coast Water Tower	Water Tower
Palm Coast Water Treatment Plant #1	302 Facility
Palm Coast Water Treatment Plant #2	302 Facility
Palm Coast Water Treatment Plant #3	302 Facility
Palm Coast Wastewater Treatment Plant #1	302 Facility
Palm Coast Wastewater Treatment Plant #2	302 Facility
Palm Coast Water Utility Office	Critical Facility

Critical Facility	Type
Palmeras Of Palm Coast	Critical Facility
Pampered Parents Alf Inc	Critical Facility
Paradise Group Home Alf	Critical Facility
Plantation Bay Utility Company	Critical Facility
Post Office (Moody Blvd)	Critical Facility
Post Office (Pine Cone Dr)	Critical Facility
Post Office (Daytona Ave)	Critical Facility
Princeton Village Of Palm Coast	Critical Facility
Road & Bridge Barn	Storage
Rose's Assisted Living Facility	Critical Facility
S & B Kingdom Care Llc	Critical Facility
Sam's Assisted Living Facility 2	Critical Facility
Somerset Of Palm Coast	Critical Facility
Somerset Of Palm Coast Ii	Critical Facility
Southern Breeze Living Llc	Critical Facility
Susie's Home	Critical Facility
T Brand Fertilizer	302 Facility
The Windsor - Town Center Ph 1	Critical Facility
Tm Tender Care	Critical Facility

APPENDIX C

List of Major Roadways

Significant Roadways

Name of Significant Road
Belle Terre Parkway
Bird of Paradise Drive
Central Avenue
Citation Parkway
Colbert Lane
County Highway 201
County Road 13
County Road 205
County Road 302
County Road 304
County Road 305
Dupont Road
E State Road/Hwy 100
Easthampton
Eric Drive
Exit 278
Exit 284
Exit 289
Farmsworth Drive
Florida Parkway Drive
Forest Grove Drive
Hammock Dunes Parkway
Hargrove Grade
Interstate-95
Lakeview Boulevard
London Drive
Londonderry Drive
Mahogany Boulevard
Main Street
Matanzas Woods Parkway
Matanzas Woods Parkway Interchange*
Moody Boulevard
North Oceanshore Blvd
Oceanshore Blvd
Old Dixie Highway
Old Kings Road
Otis Stone Hunter Road
Palm Coast Parkway
Palm Coast Parkway NE

Name of Significant Road
Palm Harbor
Parkview Drive
Pine Grove Drive
Pine Lakes Parkway
Pine Lakes Parkway N
Point Pleasant Drive
Pritchard Drive
Royal Palms Parkway
Rymfire Drive
Seminole Woods Boulevard
Sesame Boulevad
State Highway 100
State Highway 11
State Highway 13
State Highway 20
State Highway 5
State Highway A1A
State Road 100
State Road 11
Surfview Drive
Town Center Boulevard
US Highway 1
Wellington Drive
West Highway 100
Whippoorwill Drive
White View Parkway
Wynnfield Drive

APPENDIX D

Resources

Resources Cited

Federal Emergency Management Agency (2017). *National Flood Insurance Program (NFIP) Community Rating System (CRS) Coordinator's Manual.* https://www.fema.gov/media-library-data/1493905477815-d794671adeed5beab6a6304d8ba0b207/633300_2017_CRS_Coordinators_Manual_508.pdf

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APPENDIX E

Flagler County Local Mitigation Strategy – Sea Level Rise

4.11.3 Sea Level Rise

Over the last decade there has been a lot of talk about sea level rise. This phenomenon is occurring throughout the world in different ways. The overall sea level change average is increasing but different places within the world are experiencing diverse trends. Florida overall is experiencing a 1-3mm/year increase, whereas Alaska is actually decreasing in portions by 1-6mm/year. As Florida's perimeter is mostly coastline, infrastructure, residences, and our economy are highly sensitive to changes in the sea level.

There are two different types of sea level rise– eustatic and relative. Two factors directly cause the increase in eustatic sea level–thermal expansion of the oceans and melting of land ice such as the Greenland ice sheet, the Antarctic ice sheet, and land glaciers. The change is measured with tidal gauges that record variations in relation to a fixed benchmark. These tidal gauges also measure the relative sea level which refers to local lowering or rising of land through geologic processes such as subsidence and glacial rebound.

Table 4.45: Sea Level Rise Factors

Eustatic Sea Level Rise Factors	
Thermal Expansion	**Melting of Land Ice**
1. Global atmospheric temperatures rise 2. Oceans absorb heat and warm 3. Warming creates a decrease in density 4. Expansion of the ocean occurs 5. A rise in sea level occurs.	1. Rising temperatures cause ice and snowfields to melt. 2. There is an increase in the amount of water in the oceans. 3. A rise in sea level occurs.

Sea level rise has always been a major force in shaping coastlines. Within the 20th century, there has been evidence from tidal gauges of sea levels rising slowly throughout the world. Earth naturally has had periods of time where warning trends have occurred, leading to increases in sea level. The difference for our future is that the rate of sea level rise is occurring faster,

[7] http://www.mayoclinic.org/healthy-lifestyle/nutrition-and-healthy-eating/in-depth/sodium/art-20045479

exacerbated by both global temperature increase and melting land ice. This accelerated rate may cause damage to many coastal features.

The closest tidal gage to Flagler County exists in Mayport, Florida. The historical sea level rise calculated between 1928 and 2006 is recorded at an average of 2.29 mm/year. Seasonally, these levels change. March holds the lowest average mean sea level from 1928 to 2006, recorded at -0.083 meters below the average; October holds the highest at 0.211 meters above.

The Hurricane and Storm Damage Reduction Project Report conducted by the USACE Jacksonville District in 2014 for Flagler County studied the current sea level rise situation and predicted future levels. The USASCE estimated future sea level using the historic trend and two curves from the National Research Council–Intermediate and High. The table below is based on the current sea level rise trends from historic data received from the study conducted by the U.S. Army Corps of Engineers in 2014.

Table 4.46: Relative Seal Level vs. Year for Flagler County

	Baseline (Historic)			Intermediate (NRC Curve I)			High (NRC Curve III)		
	Year	mm	ft	Year	mm	ft	Year	mm	ft
Base Year	2016	9.16	0.03	2016	13.93	0.05	2016	29.05	0.10
	2021	20.61	0.07	2021	32.56	0.11	2021	70.44	0.23
	2026	32.06	0.11	2026	52.55	0.17	2026	117.49	0.39
	2031	43.51	0.14	2031	73.89	0.24	2031	170.18	0.56
	2036	54.96	0.18	2036	96.59	0.32	2036	228.53	0.75
25 Year	2041	66.41	0.22	2041	120.64	0.40	2041	292.52	0.96
	2046	77.86	0.26	2046	146.04	0.48	2046	362.17	1.19
	2051	89.31	0.29	2051	172.81	0.57	2051	437.46	1.44
	2056	100.76	0.33	2056	200.92	0.66	2056	518.41	1.70
	2061	112.21	0.37	2061	230.39	0.76	2061	605.00	1.98
50 Year	2066	123.66	0.41	2066	261.22	0.86	2066	697.25	2.29

The figure below provides a depiction of what each of the curve lines studied look like in comparison to each other.

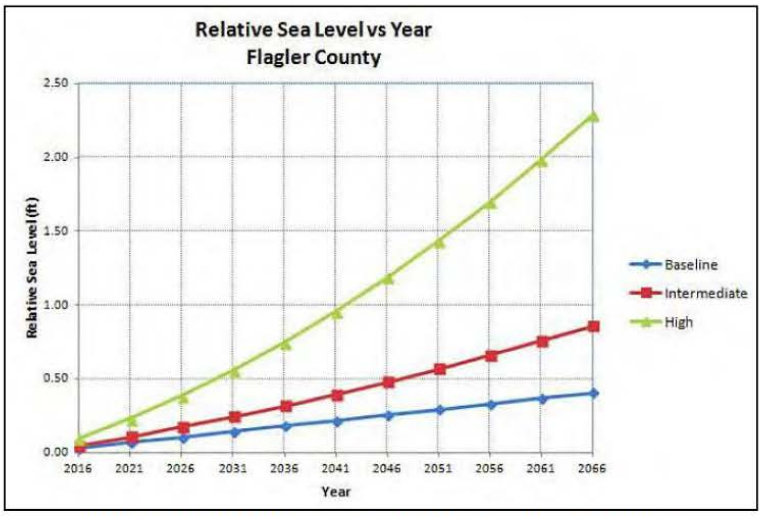

Figure 4.36: Relative Sea Level Rise Trends and Curves

Within the most extreme scenario, the sea level over the 50 year projection will reach 697.25mm (2.29 ft) above what it is today. At the historic baseline, the projection reaches 123.66mm (0.41ft) above today's level. Although it is uncertain what the sea level will reach over the next 50 years, it is probable that at minimum, sea level will follow historic trends and reach at least a 123.66mm rise in the next 50 years.

Using the best data available, the map below depicts where sea level rise of different magnitudes might affect the county. As expected, areas along Crescent Lake and the Intracoastal would be majorly affected, even by a 1 foot increase in sea level.

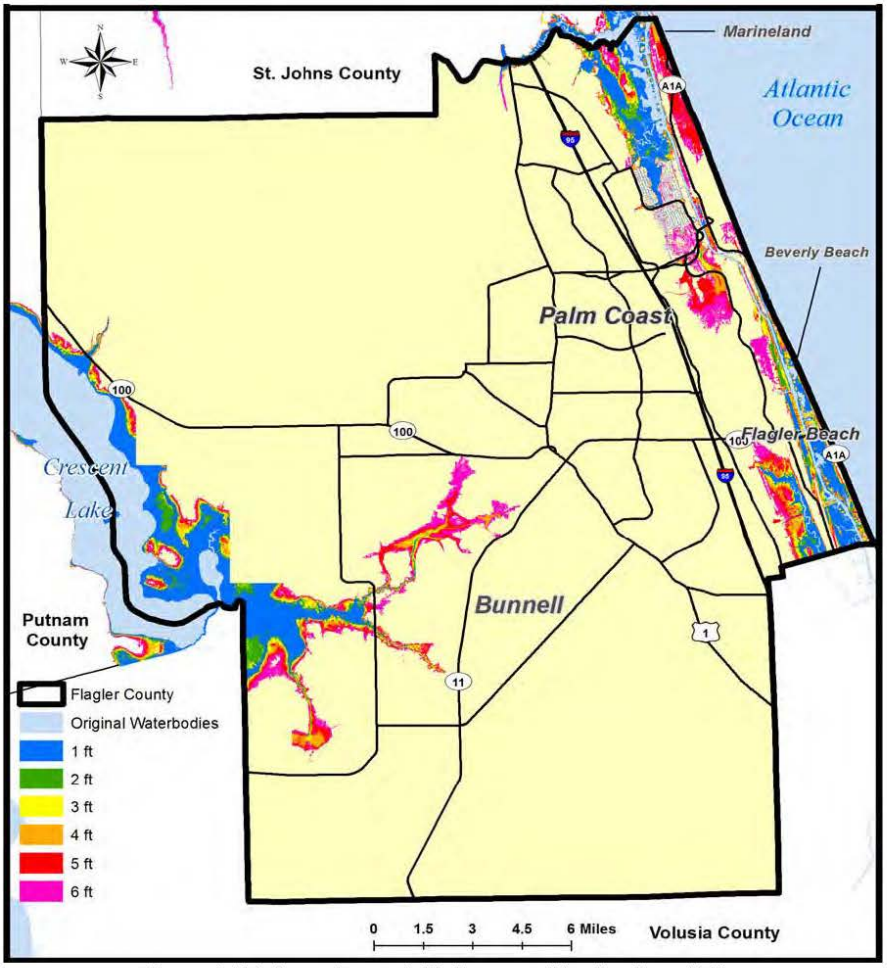

Figure 4.37: Areas Potentially Impacted by Sea Level Rise
Data Source: NOAA Coastal Services Center

Looking at the data for the highest projection, the areas that would be inundated include parts of Marineland, Flagler Beach and Beverly Beach along the Intracoastal Waterway. At the highest possible sea level rise (2.29ft) over the next 50 years, several conditions may be present:

- Property and infrastructure damage
- Increase in storm surge effects
- Species and habitat loss
- Movement/destruction of dune systems
- Population displacement
- Job loss

Nearly half of Flagler County's infrastructure exists within floodplains. These floodplains are highly susceptible to sea level rise. If sea level was to reach the 2.29 foot marker, much of the inundation would occur in areas that are highly residential such as Palm Coast and homes in and around Bulow Plantation Ruins Historic State Park. If damage becomes severe, these populations will have to relocate to a different area. Recreation will be directly affected under these conditions, particularly within the intracoastal waterways. As most of the area will expand and become flooded, many of the public beach access points and boat ramps may be damaged, particularly Bing's Landing, Varn Park, and Herschel King Park. Damage to businesses, depletion of beaches for tourist revenue, and damage to resorts will cause significant economic side effects.

On coastlines, there will be landward migration of the dune systems as the waves and winds continually push the sand. Coastal squeeze may eventually deplete the dune systems altogether if infrastructure is present behind the existing dunes. Lack of sand and dune ecosystems will create a significant loss in habitat for shorebirds, sea turtles, reptiles, and other shoreline species.

The following table was constructed after using ArcGIS to gather the data on the areas inundated from sea level rise. This information is based on the historical sea level rise of 2.4mm found for Flagler County.

Table 4.47: Potential Property at Risk from Sea Level Rise

Rise	Value of Property ($)	Number of Properties	Number of Critical Facilities
1 ft.	1,306,198,188	5,671	0
2 ft.	1,409,238,474	6,269	3
3 ft.	1,500,714,824	7,004	3
4 ft.	1,598,405,892	7,719	3
5 ft.	1,966,237,987	9,869	3
6 ft.	2,513,780,321	12,643	5

This hazard affects a multitude of property types. Of the number of properties listed above, a majority of them include residences up to a two mile radius of the coastline. Although most of the initial inundation will be within the barrier islands and along the Intracoastal Waterway, the canal systems within Palm Coast and the low lying areas south of 100 in Flagler Beach will become inundated at only a 1 foot increase. The Palm Coast residential zone is of very high susceptibility at only a one foot increase in sea level. At this level almost all homes north of Palm Coast Parkway SE and southeast of Matanzas High School will be surrounded with water. Matanzas High School itself has a high enough elevation that this area will not be inundated by sea level past 6ft. Within Flagler Beach, much of the inland inundation will initially consume the residences east of the Matanzas River and some properties adjacent to John Anderson Hwy. Properties north of Bulow Plantation Ruins Historic State Park will be inundated at 1 ft sea level, including around 30 residential homes which would be affected. Sea level rise will impact access to places and may undermine the stability of roads.

Sea Level Rise and its Effects on Storm Surge

A recent study examined the effects of one meter of sea level rise on storm surge in Flagler County using HAZUS. Using Hurricane Floyd (1999) as an example, two storm surge scenarios were created—one with base sea level and one with 1 meter of sea level rise— to examine how storm surge impacts would change given different levels of the sea. While Floyd was projected to brush the Florida east coast and eventually make landfall at or near Flagler County, it eventually curved northward leaving a wake of severe beach erosion and some wind damage along the beaches.

Figure 4.39: Hurricane Floyd east of Savannah, GA (NOAA, 1999)

Method

HAZUS allows the user to select a scenario for creating a storm based upon several input methods. For this particular study, the option to <create your own scenario> was used to select a number of geographic points, wind speeds, and trajectory information based upon one of Hurricane Floyd's early projected paths. This new storm was named "Floyd Prime". The following map is a HAZUS generated prediction of wind speeds based on the proposed "Floyd Prime" track.

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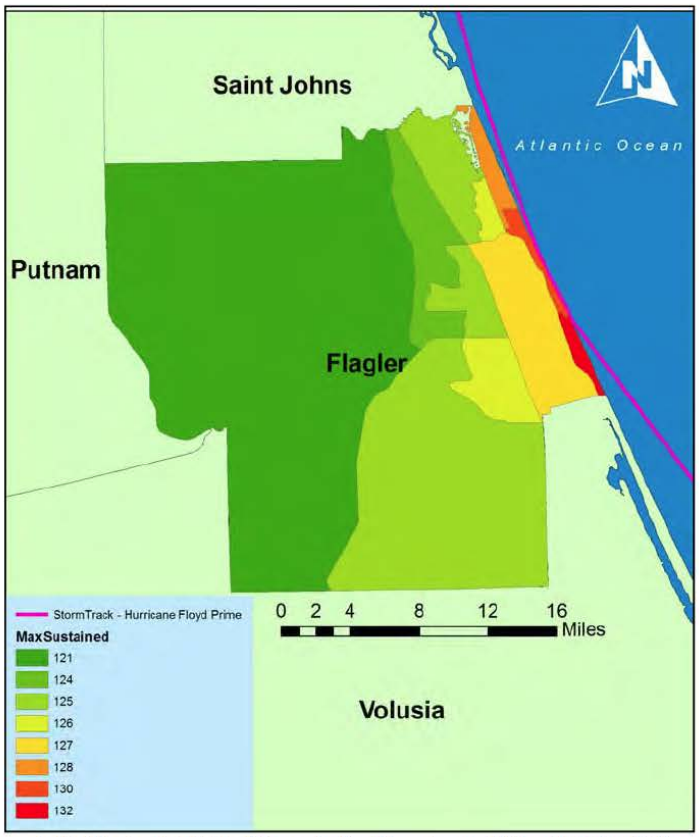

Figure 4.40: Projected Wind Speeds for Hurricane "Floyd Prime" Scenario
Taylor Phillips Capstone Project/HAZUS, 2015

Two models were run: the first without sea level rise, and the next with one meter additional sea level. Both models treated Floyd Prime as a 100 year event, while the model with one meter of sea level rise used 3.208 additional feet of stillwater elevation on top of a 10 foot stillwater depth and a 2 foot wave setup derived from the last FEMA Flood Insurance Study for Flagler County.

After the models in HAZUS were run, the following maps were produced that exemplify the effects of sea level rise on storm surge.

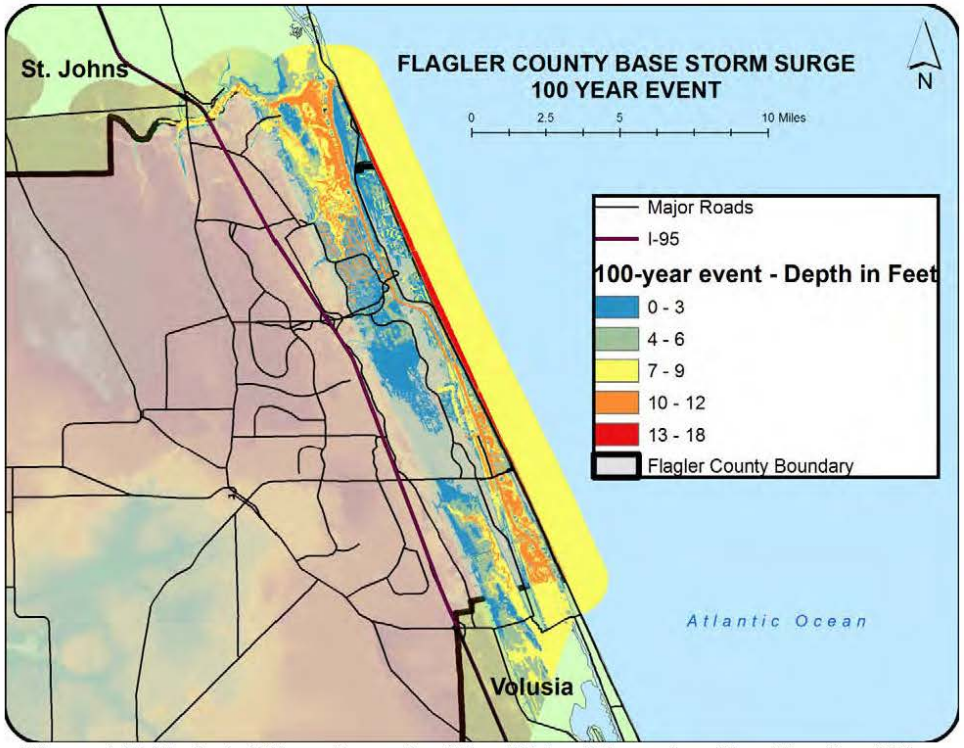

Figure 4.41: Projected Storm Surge for "Floyd Prime" Scenario without Sea Level Rise
Source: Taylor Phillips Capstone Project/HAZUS, 2015

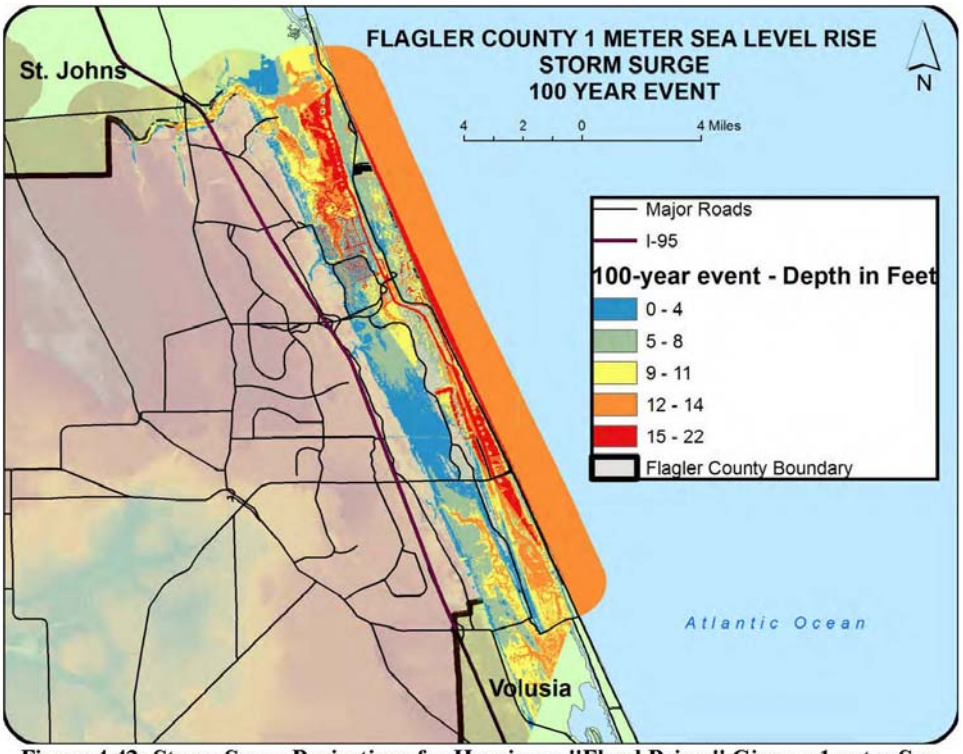

Figure 4.42: Storm Surge Projections for Hurricane "Floyd Prime" Given a 1meter Sea Level Rise

Source: Taylor Phillips Capstone Project/HAZUS, 2015

Results and Analysis

One meter of sea level rise can increase storm surge by over four feet in some cases, up to a total of 22 feet. While this case is extreme, the inundation distance is also considerably farther inland. Palm Coast has several canals that are lined with expensive housing that could be under water in high storm surge events.

The following tables are HAZUS outputs for the first model with no sea level rise for Hurricane "Floyd Prime". Notable results include:

- 3,307 buildings are at least moderately damaged (30% of total in the scenario)
- 397 (10%) completely destroyed
- Almost all buildings that could be affected are residential (76%)
- 100% of manufactured housing would be substantially damaged (180 units)

- $741 million in total damages could be incurred by "Floyd Prime"
- $2.5 million in business interruptions may be incurred.

Building Damage

General Building Stock Damage

Hazus estimates that about 3,307 buildings will be at least moderately damaged. This is over 30% of the total number of buildings in the scenario. There are an estimated 307 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		Substantially	
Occupancy	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	2	33.33	3	50.00	1	16.67	0	0.00	0	0.00	0	0.00
Education	1	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	0	0.00	1	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Religion	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	9	0.27	534	16.13	1,110	33.52	479	14.47	872	26.34	307	9.27
Total	12		538		1,111		479		872		307	

Table 4: Expected Building Damage by Building Type

Building Type	1-10		11-20		21-30		31-40		41-50		Substantially	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Concrete	0	0.00	18	18.00	33	33.00	14	14.00	31	31.00	4	4.00
ManufHousing	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	180	100.00
Masonry	7	0.31	383	17.11	787	35.17	352	15.73	616	27.52	93	4.16
Steel	1	25.00	3	75.00	0	0.00	0	0.00	0	0.00	0	0.00
Wood	1	0.12	139	17.14	292	36.00	117	14.43	230	28.36	32	3.95

Figure 4.43: HAZUS Damage Outputs for "Floyd Prime" with no Sea Level Rise
Source: Taylor Phillips Capstone Project/HAZUS, 2015

Economic Loss

The total economic loss estimated for the flood is 744.04 million dollars, which represents 21.18 % of the total replacement value of the scenario buildings.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 741.56 million dollars. 0% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 76.85% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	348.81	34.80	7.36	3.63	394.60
	Content	221.91	82.81	14.67	24.44	343.84
	Inventory	0.00	0.88	2.03	0.21	3.13
	Subtotal	**570.72**	**118.49**	**24.07**	**28.29**	**741.56**
Business Interruption						
	Income	0.04	0.49	0.00	0.08	0.61
	Relocation	0.64	0.09	0.00	0.03	0.76
	Rental Income	0.26	0.05	0.00	0.00	0.31
	Wage	0.11	0.39	0.00	0.31	0.81
	Subtotal	**1.05**	**1.01**	**0.00**	**0.42**	**2.48**
ALL	**Total**	**571.77**	**119.50**	**24.07**	**28.70**	**744.04**

Figure 4.44: HAZUS Outputs for "Floyd Prime" with no Sea Level Rise

Source: Taylor Phillips Capstone Project/HAZUS, 2015

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The following tables are HAZUS generated outputs for Hurricane "Floyd Prime" storm surge with 1 meter of sea level rise and a 2 foot wave setup during normal astronomical tides.

Building Damage By General Occupancy

November 09, 2015

All values are in thousands of square feet

		Square Footage Distribution by Damage Percent Range						
	Total Square Footage	None	1-10	11-20	21-30	31-40	41-50	Substantial
Florida								
Flagler								
Agriculture	24.00	0.00	0.00	9.00	7.00	1.00	5.00	2.00
Government	25.00	3.00	0.00	14.00	6.00	2.00	0.00	0.00
Residential	19,572.00	2,410.00	33.00	1,004.00	4,471.00	2,665.00	7,258.00	1,731.00
Religion	138.00	8.00	7.00	96.00	13.00	3.00	6.00	5.00
Education	129.00	10.00	4.00	44.00	64.00	2.00	5.00	0.00
Commercial	1,580.00	63.00	24.00	377.00	342.00	289.00	261.00	224.00
Industrial	390.00	39.00	0.00	18.00	66.00	126.00	53.00	88.00
Total	21,858.00	2,533.00	68.00	1,562.00	4,969.00	3,088.00	7,588.00	2,050.00
Total	21,858.00	2,533.00	68.00	1,562.00	4,969.00	3,088.00	7,588.00	2,050.00
Scenario Total	21,858.00	2,533.00	68.00	1,562.00	4,969.00	3,088.00	7,588.00	2,050.00

Figure 4.45: HAZUS Damage Outputs for "Floyd Prime" given 1 meter of Sea Level Rise

Source: Taylor Phillips Capstone Project/HAZUS, 2015

Building Damage

General Building Stock Damage

Hazus estimates that about 7,956 buildings will be at least moderately damaged. This is over 31% of the total number of buildings in the scenario. There are an estimated 822 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		Substantially	
Occupancy	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	0	0.00	18	62.07	7	24.14	4	13.79	0	0.00	0	0.00
Education	0	0.00	0	0.00	1	100.00	0	0.00	0	0.00	0	0.00
Government	0	0.00	1	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	100.00
Religion	0	0.00	3	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	0	0.00	481	6.07	2,237	28.24	1,182	14.92	3,200	40.40	821	10.36
Total	0		503		2,245		1,186		3,200		822	

Table 4: Expected Building Damage by Building Type

Building Type	1-10		11-20		21-30		31-40		41-50		Substantially	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Concrete	0	0.00	17	5.69	99	33.11	46	15.38	126	42.14	11	3.68
ManufHousing	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	345	100.00
Masonry	0	0.00	344	6.43	1,571	29.39	842	15.75	2,247	42.03	342	6.40
Steel	0	0.00	11	61.11	3	16.67	3	16.67	0	0.00	1	5.56
Wood	0	0.00	129	6.51	585	29.50	298	15.03	849	42.81	122	6.15

Figure 4.46: HAZUS Building Stock Loss Output for "Floyd Prime" with 1 meter of Sea Level Rise

Source: Taylor Phillips Capstone Project/HAZUS, 2015

Key findings for 1 meter of sea level rise include:

- 7,956 buildings likely to be at least moderated damaged, over twice as many than scenarios with no sea level rise
- 822 buildings will be substantially damaged, nearly all of them residential
- Again, 100% of manufactured housing will be substantially damaged; this time over 300 units are inundated with the additional sea level rise
- Over 2 million square feet of building space will be inundated, 1.7 million of which are residential

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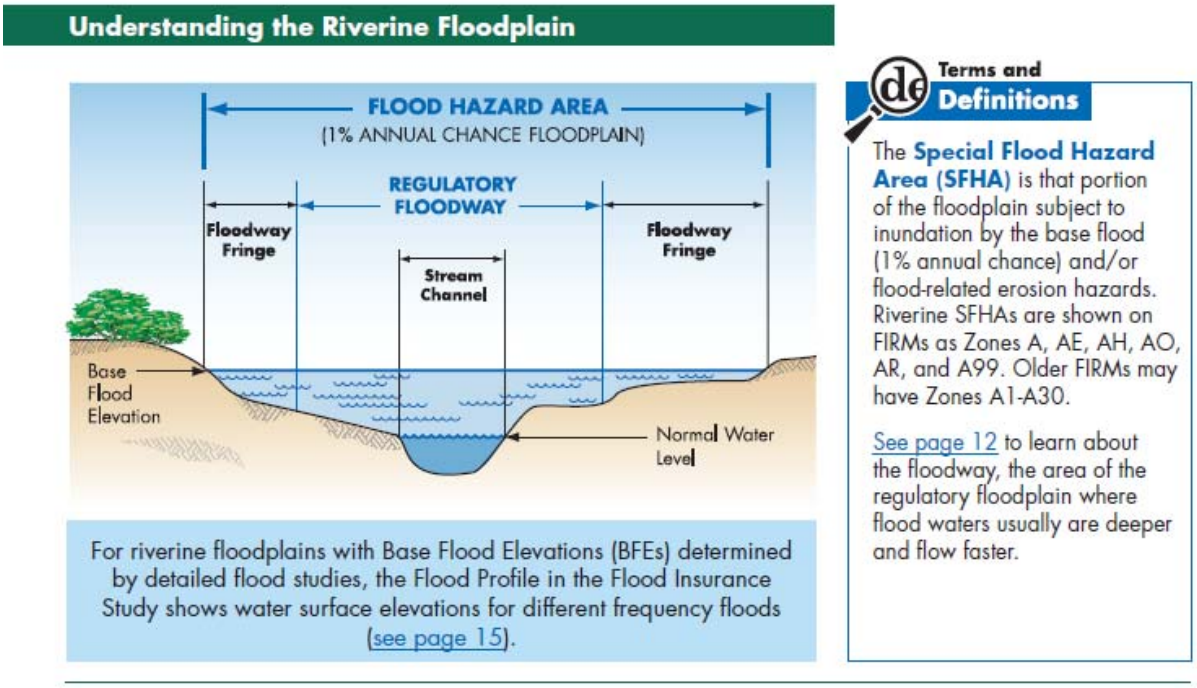
APPENDIX F

Definitions

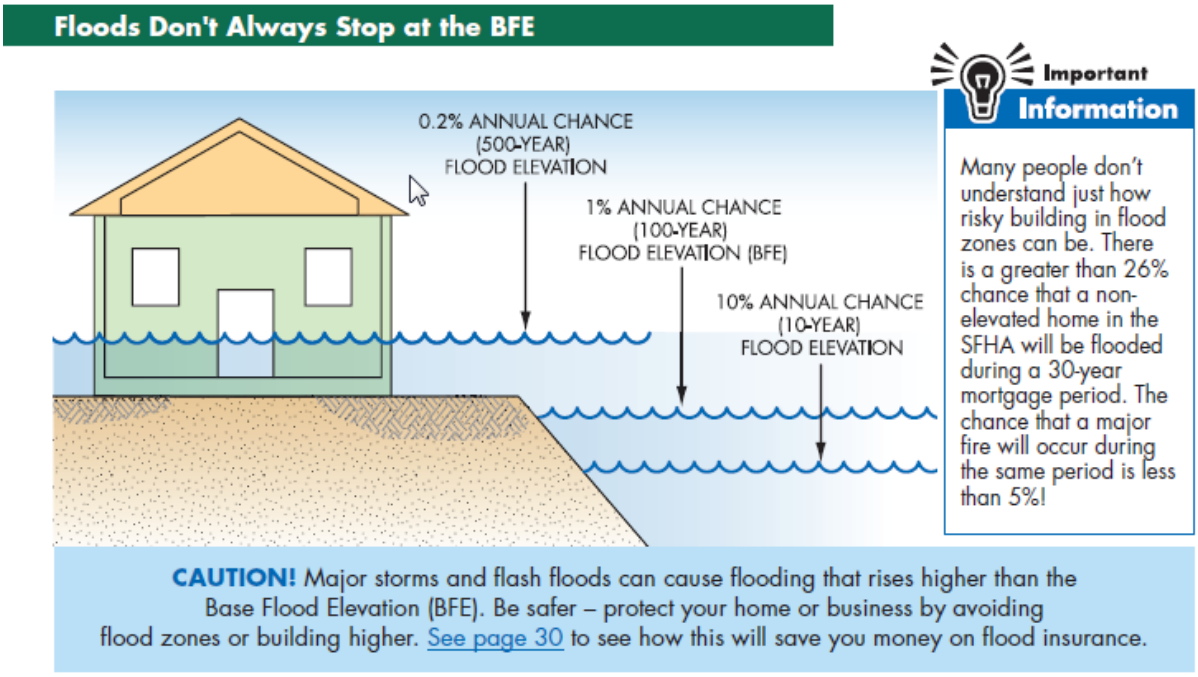
Definitions

Base Flood Elevation (BFE): The computed elevation to which floodwater is anticipated to rise during the base flood. Base Flood Elevations (BFEs) are shown on Flood Insurance Rate Maps (FIRMs) and on the flood profiles. The BFE is the regulatory requirement for the elevation or flood proofing of structures. The relationship between the BFE and a structure's elevation determines the flood insurance premium.
Source: FEMA

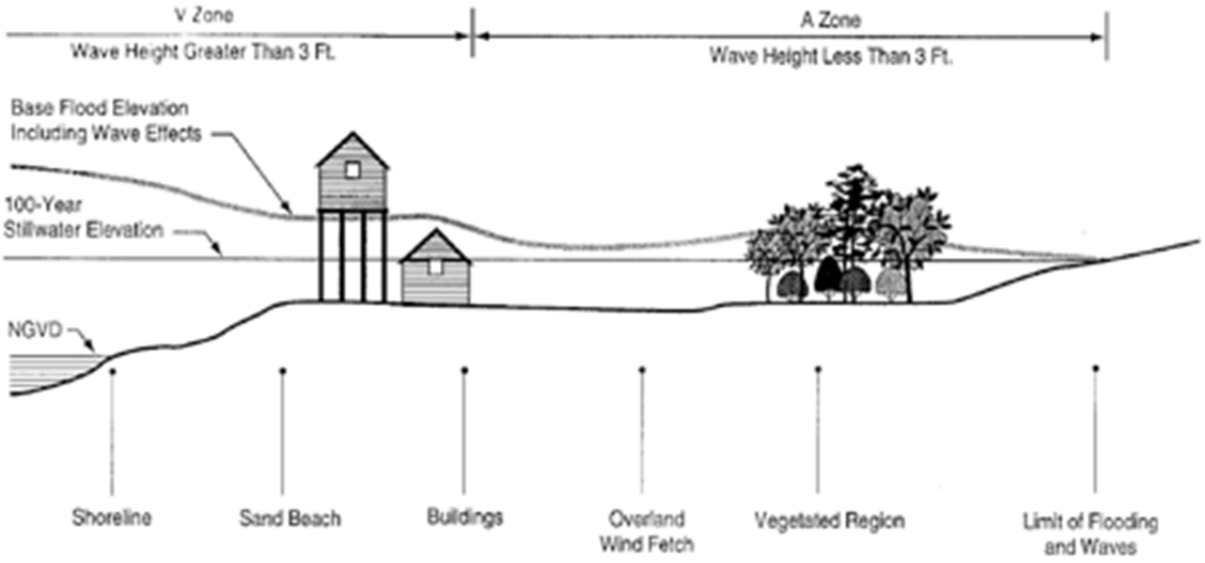
Mean Sea Level: The arithmetic mean of hourly water elevations observed over a specific 19-year tidal epoch.
Source: NOAA



Source: Florida Division of Emergency Management: Floodplain Management Quick Guide, 2017



Source: Florida Division of Emergency Management: Floodplain Management Quick Guide, 2017



Source: Mapping the Zone, Improving Flood Map Accuracy (2009)

Resilient Flagler County

2018